VOLUME 8 ARCHAEOLOGY OF THE MAYA

The Maya and Environmental Stress from Past to Present

Human response and adaptation to climate change in the Maya lowlands

EVA JOBBOVÁ

BAR INTERNATIONAL SERIES 3055

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EVA JOBBOVÁ

WITH CONTRIBUTIONS FROM
SEAN DOWNEY, CHRISTOPHE HELMKE
AND ANDREW BEVAN

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COVER IMAGE *Detail of a limestone pier of Temple XIX at Palenque, showing a priest of the royal court, bearing the title of yajaw k'ahk' ('vassal of fire'). In joining hands with K'inich Ahkul Mo' Naahb, the ruler of Palenque, the priest supports the monarch in his ritual attire.*

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To mum and dad

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Abstract

The perceived successes and failures of the Maya are often both linked to their relationship with the local environment and their response to episodes of climate change over a period of nearly 2000 years. However, our understanding of human responses to environmental stress has mostly been shaped by a narrow focus on drought as a cause for societal collapse, even in relatively well-watered tropical regions. We still know little about the choices humans make in response to extreme variability in rainfall in different environmental conditions and on multiple timescales.

This project responds to recent debates and new analytical opportunities in Maya archaeology, provided by developments such as an increased volume of paleoclimatic data, the growing field of settlement archaeology and advances in Maya epigraphy. By combining a range of evidence, I explore the relationship between Maya society and the local environment on multiple spatial and temporal scales, while also taking into account socio-cultural agencies. In addition, results from ethnographic fieldwork among contemporary Maya communities provide insights into the impact of stress-inducing climatic events on people's lives and their coping strategies. These serve as a guide when looking for similar patterns in archaeological and textual evidence.

The results demonstrate that drought is a real phenomenon in the Maya neotropics, with the potential to affect peoples' lives, despite a widespread assumption that water supplies are abundant and unproblematic in such environments. Evidence both for episodes of environmental stress and for effective strategies that ancient (and modern) Maya used to cope with these episodes is visible in different ways, such as changes in settlements, subsistence strategies, water management and ritual activity. In fact, I argue that the drought-related ritual activities that can still be identified in contemporary Maya communities today can be traced back to the Classic Maya period, and I suggest that two specific rituals appearing in the Terminal Classic texts are very likely planting and rain-beckoning rituals and are potentially linked with episodes of environmental stress. In addition, results from an exploration of human-environment relationship in different regions emphasise the variability present in Maya perceptions of and responses to adverse conditions depending on both environmental and cultural factors.

1

Introduction

Between circa AD 250 and 800 (the Classic period), the Maya civilisation witnessed a period of increasing social complexity, accompanied by large-scale architectural construction and urbanism, widespread use of hieroglyphic inscriptions on monuments, and technological and artistic development. The political structure of this period was characterised by densely populated city-states, which normally operated independently but also sometimes formed alliances or claimed dominance over each other. During this era, most of the politically- and culturally-dominant Maya centres were located in the central lowlands. The focus of dominant Maya centres shifted over time, from the southern highlands during the Preclassic period, to the central lowlands in the Classical period, and eventually to the more northern parts of the Yucatan peninsula during the Postclassic (Folan et al. 1983a; Demarest 2004a). In the middle of this longer history, the decline and apparent abandonment of many of the prominent central lowland Classic Maya centres during the 8th and 9th centuries AD (a period referred to as the Terminal Classic period) was accompanied by a cessation of monumental architectural construction and diminished use of inscriptions.This seems to reflect a decrease in social stratification, a decentralisation of power, ideological change and, ultimately, a breakdown of the traditional framework of 'divine kingship' (Freidel 1992: 99; Santley et al. 1986: 123; Willey 1986: 31).

Often, the perceived successes and failures of the Maya are linked to their relationship with the local 'neotropical' (Schultz 2005) environment and, in some cases, to their response(s) to different episodes of suggested episodes of climate change over a period of nearly two thousand years. The early Maya archaeologist, J. Eric S. Thompson, once commented: '… to me, one of the greatest mysteries is why Maya culture should have reached its greatest peak in this region so singularly lacking in natural wealth, where man, armed only with stone tools and fire, had everlastingly to struggle with the unrelenting forest for land to sow his crops' (Thompson 1954: 26). Thompson's view illustrates well the portrayal of the Maya during the first half of the 20th century: living in the 'least desirable environment' (Lowe 1971: 237), unsuitable for monumental architecture, and depending on non-intensive slash-and-burn (swidden) agriculture as their main means of subsistence (Bullard 1964). Early investigations into the archaeology of the Maya mainly focused on the excavation of the monumental cores of sites, which did little to dispel perceptions of Maya sites as vacant ceremonial centres inhabited only by rulers and priests who were primarily concerned with astronomical observations, recording the passage of time, and performing religious ceremonies. The land outside the monumental centre was seen as occupied by peasants in dispersed hamlets, relying on swidden agriculture to produce enough food for themselves and for the priestly rulers living in the ceremonial centres.

In the late 1960s, the 'vacant ceremonial centre' view started to be revised with a growing focus on the settlement beyond monumental cores. Settlement surveys conducted at sites, such as Tikal, Guatemala and Copan in Honduras, facilitated estimates of overall population, recast our sense of what constituted a Maya 'city,' and proposed more labour-intensive models of Maya agriculture, besides swidden, as a main means of subsistence (Harrison and Turner 1978; Sanders 1979; Adams 1980; Siemens 1982; Lohse 2004). In addition, studies focused on the details of environmental variability and available resources further challenged the view of Maya lowlands as a hostile and resource-scarce environment (e.g., Graham 1987).

An increasing interest in climate change within the last few decades has led to a vast amount of palaeoclimatic data being collected from the Maya area, data which indicate considerable changes in rainfall patterns during the mid- to late Holocene (Brenner et al. 2002; Leyden 2002; Rosenmeier et al. 2002a, 2016; Wanner et al. 2008; Webster 2007; Kennett et al. 2012). These data gave rise to studies, such as those by Gunn and Adams (1981) and Folan and colleagues (1983a), that associated the rapid growth of Maya culture with cooler and wetter periods and its decline with drier and warmer periods. Others have argued that the variation in climate patterns explains the shift in power among major Maya centres (Folan 1977, 1980; Folan et al. 1983b; Kurjack and Garza 1981) and the movement in population concentrations from inland to coastal areas and back again (Folan 1978). There have also been many other environmental studies conducted in the Maya area, with emphases ranging from the development of agricultural economies, the implications of intensive food production, the development of social stratification and state-level society, and ultimately the possible relationships between climate and the perceived Classic Maya 'collapse'.

Many studies, especially those focusing on climate, have been criticised, however, for oversimplifying cause and effect or for being environmentally deterministic in ignoring the importance of cultural and social factors, such as religion, ideology, political strategies and economic organisation. '… [I]n the pursuit of a universal causal factor – climate – history and process have been left out. But it is in the history of a society, seen in the context of general processes, that we will understand why a society responds to climate stress in one period by growing in complexity and in another by collapsing' (Tainter 2000:

337; see also Flannery 1972). In Maya archaeology, we are fortunate that some glimpses of Maya-event scale history at least can be gleaned from hieroglyphic texts although, as with other past societies with surviving written records, the process of extracting the information from these records is less straightforward than we would wish or might at first expect. After the breakthrough in the decipherment of Maya hieroglyphs in early 1950s (Knorozov 1952) and later, the overturning of the idea that Maya hieroglyphic writing did not contain historical accounts (Proskouriakoff 1960), we now have an exceptional opportunity to look more closely at some of the missing socio-cultural issues. We know a great deal more now than we did ten years ago about Maya political organisation, dynastic histories, worldview and religion (e.g., Houston and Stuart 2001; Houston, Stuart and Taube 2006; Martin and Grube 1995, 2000, 2008; Stuart 2005).

However, despite all of these advances and new strands of evidence, we still know very little about either the short- or the long-term dynamics of human-environment relationships in the Maya region. For example, we still do not fully understand how societies respond to unexpected variability in rainfall patterns in different environmental conditions and at different timescales. Does society become increasingly complex? Is collapse inevitable? Do people simply move, and if so, why? Do their ideological and religious beliefs change or do they remain the same?

This book engages with these debates and the new analytical opportunities in Maya archaeology, and attempts to address a continuing void in our knowledge of how the Maya responded to environmental variability by examining information from: (a) the growing field of settlement archaeology, (b) increasing number of palaeoclimatic datasets, and (c) advances in Maya epigraphy and decipherment. The characterisation of Maya settlement through time, the understanding of cultural and political trajectories through epigraphy, and the study of Maya responses to the environment have not been embraced by a single and coherent study. I will, therefore, explore the relationship between Maya society and the local environment over the long term, while taking into account socio-cultural agency via information from the written record. A complementary strand of evidence – an exploration of very recent Maya responses to environmental stress, based on ethnographic fieldwork conducted in Belize (Downey and Jobbová 2011) – is also presented as a sort of bridge, connecting the past with the present.

More specifically, I will be addressing the following questions:

- How did Maya communities and their inhabitants deal with environmental stress, drought in particular? Where we have records of adverse rainfall conditions, is response to stress evident in settlement patterns, agricultural and water strategies, or in the written records?
- What can we learn about the relationship between Maya society and the environment through the examinination of a range of evidence over the long term and in different regions?

The questions will be examined in several stages, and through answering following sub-questions:

- How can environmental stress be defined and recognised?
- What can we learn from the historical period and ethnographic present about modern Maya responses or adjustments to spatial and temporal variation in weather patterns? How does knowledge of the range and kind of responses help us to recognise patterns related to climate change in the past?
- What can we learn from long-term climate records about variation and change in the weather patterns within the study regions?
- Are there changes in micro-regional Maya settlement patterns through time?
- Do Maya agricultural and water management strategies change through time?
- What can we learn from the written records (texts from the Early and Late Classic, versus Terminal Classic and Postclassic period)?

Combining such different datasets in a single study is still rare in Maya studies, therefore, after providing the environmental and archaeological context in Chapter 2, the theoretical and methodological framework behind combining approaches drawn from anthropology, archeology and epigraphy are discussed in Chapter 3.

Chapter 4, based on ethnographic fieldwork among contemporary Maya communities, explores how climate events, such as droughts, floods, and hurricanes, affect people's lives, how people react to these events, and what mitigation strategies they develop. The aim of this chapter is to gain a better understanding of the human-environment relationship at the level of human decision-making on shorter timescales, thereby adding a much-needed behavioural context. The chapter then serves as an exploratory groundwork when looking for similar patterns in archaeological and textual evidence in following chapters. Chapter 5 presents the palaeoclimatic data for the case study regions, which is then used for comparative purposes in the next three chapters. Evidence for the spatial and temporal variability in the climate record over long time periods is derived from long-term proxy data derived from lake sediments, speleothems and cave sediments.

Chapter 6 focuses on ancient Maya and explores settlement histories in the case study regions by considering chronology and rates of occupation through time. Variation in the extent and layout of the settlements, degree of nucleation, and indications of change or stasis were also important criteria. Chronology of occupation and settlement patterns were examined on both regional, as well

as local inter- and intra-site scales, using settlement and excavation data from projects carried out in the case study regions. In Chapter 7, settlement histories in individual regions are viewed through an exploration of the variation in environmental conditions such as soils, water sources and rainfall patterns, particularly how these factors, singly or in combination, potentially influence agricultural and water management strategies and settlement patterns.

Chapter 8 provides another context, this time socio-cultural, by exploring cultural and political histories in the case study regions, including the analysis of changes seen in the epigraphic record between the Classic and the Postclassic, the period known as the Terminal Classic. This transitional period witnessed considerable changes in the Maya area and covers the period of the Maya 'collapse', therefore, these records were of especial interest. Political alliances, the effects of warfare on settlements, the relationship between settlements and their hinterlands, and changes in iconography and in what was recorded are all explored.

Chapter 9 synthesises the results of the analyses and observations from the previous five chapters, discusses the explored questions in a more comprehensive way, including wider global and modern implications of the findings from this project.

2

Setting the Scene: The Physical and Human Geographies of the Central Lowlands

Maya complex societies covered an extensive geographic area of some 324,000km^2 across the modern states of Belize and Guatemala, as well as southeastern Mexico, western Honduras, and northern El Salvador (Culbert 1973: 5-11; Handbook of Middle American Indians) Fig. 2.1. This region encompasses a vast area with varied environments, from the mountainous regions of the Sierra Madre to the semi-arid plains of northern Yucatan. In the chapters that follow, I will focus on two sub-regions, used as case study areas, deliberately chosen because they represent different environmental and cultural settings: a) the Belize River Valley and Peten Lakes area situated in the riverine central lowlands and b) the Northern Yucatan and Northern Quintana Roo in the karst northern lowlands (described in more detail below). The overall timescale spans from the Middle Preclassic (circa 1000 to 400 BC) to the Early Colonial period (1500/1600 AD), with the written records mainly covering the Classic period (AD 250– 950/1100) and ethnographic and ethnohistoric data that mainly cover the present (about the last 100 years). The climate, environmental conditions, and settlement and cultural histories will be described in more detail in Chapters 5, 6, 7 and 8; what follows is a brief description of the environmental settings and settlement histories.

2.1. Environmental setting

The Maya civilisation occupied the Yucatan Peninsula and the adjacent regions of Mesoamerica, an area that today includes the Mexican states of Yucatan, Quintana Roo, Campeche, part of Chiapas and Tabasco, and the countries of upper Central America: Guatemala, Belize, El Salvador and western Honduras. As the largest sub-region in Mesoamerica, the Maya area encompassed a very varied landscape, including both mountainous regions and semi-arid plains. In fact, considering its size, the Maya area is one of the most environmentally variable regions on earth (Sharer and Traxler 2006: 20). In the broadest terms, the area is divided into the Maya lowlands in the north and Maya highlands in the south. This study focuses on the Maya lowlands, the heart of the Maya civilisation. The lowlands have been broadly divided into northern and southern lowlands, with the latter being sometimes further divided into central and southern parts (Sharer and Traxler 2006: 24, 42).

The Yucatan Peninsula, which encompasses most of the Maya lowlands, is a large shelf composed of carbonate rock, mainly limestone, characterised by a karstic environment (Wilson 1980: 7). In such an environment, water percolates rapidly through the porous bedrock (Wilson 1980: 7; Weidie 1985). Karst processes vary in intensity across the Maya lowlands and consequently determine groundwater availability. In the northern lowlands, water runs not far below the surface and is accessible through subterranean water sources, such as sinkholes and *cenotes* or manmade wells. In contrast, the southern lowlands area has surface water sources, such as rivers, streams and lakes, although some parts, especially in the central lowlands, lack surface water. Here, the water table lies deep below the surface and is difficult to access (Dunning et al. 1998: 88).

Geological structure, drainage, and climatic patterns also determine soil distributions across the Maya lowlands. Soils, mostly calcareous clays, are especially thin in the northern lowlands due to the low rainfall and wind erosion. In the southern lowlands, soils are generally deeper, at least in comparison to northern regions, but the depths vary depending on topography (Isphording and Wilson 1973; Dunning et al. 1998: 88). Another

Table 2.1. The chronological framework of Maya civilisation (after Sharer 2006: 98)

Period	Estimated dates	Major cultural developments
Early Preclassic	2000–1000 BC	Initial complex societies
Middle Preclassic	1000–400 BC	Growth in socioeconomic complexity
Late Preclassic	400 BC–AD 100	Initial states
Terminal Preclassic	AD 100–250	Decline and transformation of states
Early Classic	AD 250–600	Expansion of lowland states
Late Classic	AD 600–800	Apogee of lowland states
Terminal Classic	AD 800–900/1100	Decline and transformation of states
Postclassic	AD 900/1100–1500	Reformation and revival of states

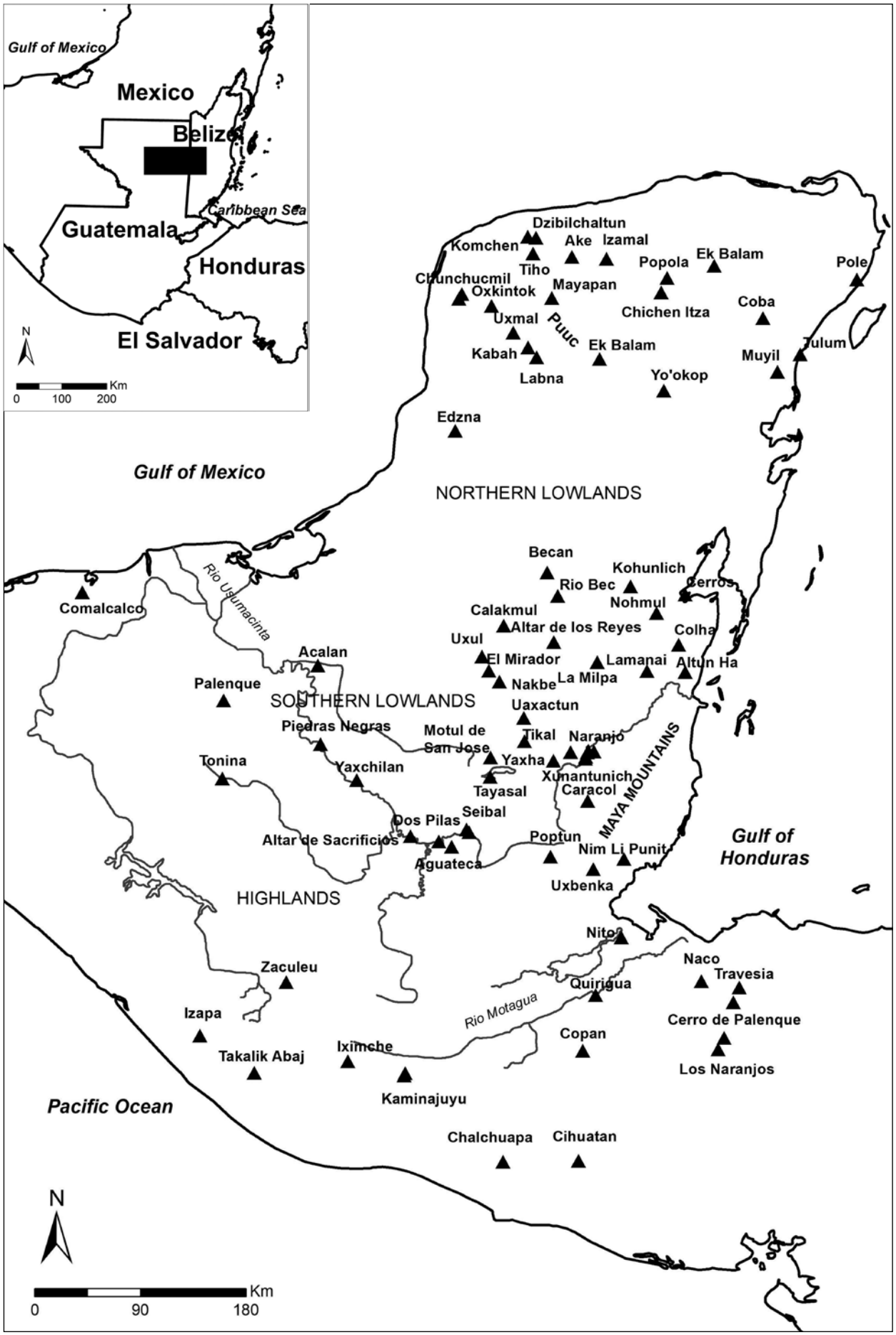


Figure 2.1. Map of the Maya area.

important environmental factor that varies greatly across Maya lowlands is rainfall. The mean annual rainfall ranges from as little as 450–500mm per year in the driest area of the northwest coast of Yucatan, near Progresso, to more than 4000mm in the southeastern coastal region of Belize (Fig. 2.2). Micro-topography within regions contributes to considerable local variability of rainfall, especially in the broken terrain of the southeastern lowlands. For example, in Belize, annual rainfall ranges from 1524mm in the north to 4064mm in the south.

As a tropical environment, the Maya Lowlands experiences two main seasons: rainy and dry; rainfall also varies seasonally. The rainy season usually begins in late May/early June and runs until November/December (briefly interrupted by drier conditions in late July/early August). The period from December until early May is the dry season (Magaña et al. 1999). Mean annual temperatures are relatively high, ranging between 25° and 38° Celsius. The geographical and seasonal variabilities in temperature are much less than in the case of rainfall.

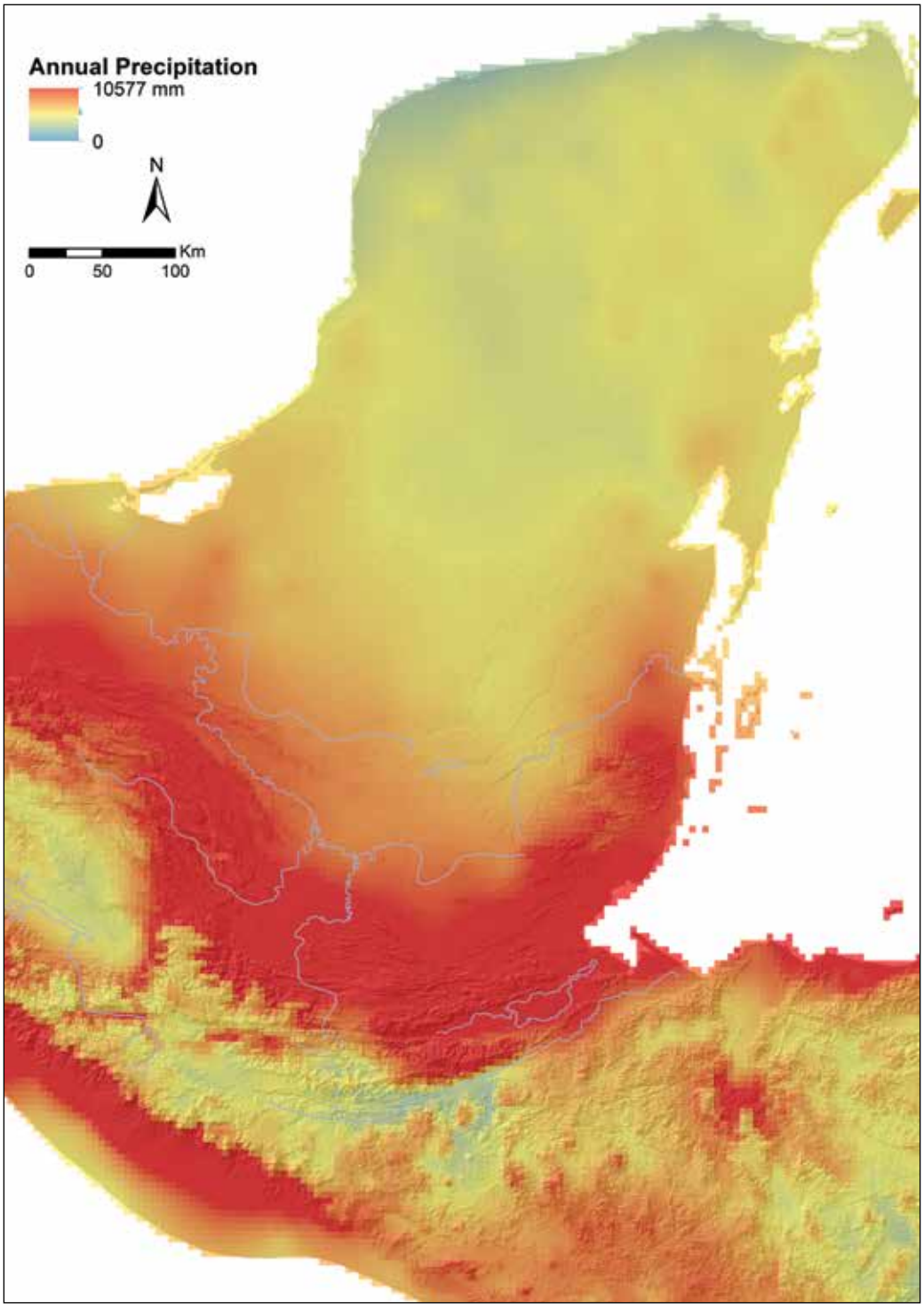


Figure 2.2. Distribution of annual rainfall across the Maya area (www.ncdc.noaa.gov).

2.2. Case study regions

The project focused on two sub-regions in the Maya world, which were chosen based on the following criteria: (a) the availability of data covering all domains of the research: the environment (especially palaeoclimatic records), settlement, and recorded history; and (b) an objective to capture regional differences in environmental and cultural behaviours in the Maya area. Differences in environmental settings (e.g., soils, water access, rainfall patterns) across the Maya area are considerable and can have a significant effect on settlement patterns, agricultural strategies, access to water and water management. Similarly, cultural, political and economic factors (e.g., political organisation, economy types, socio-political complexity) vary and would have influenced cultural and political histories and trajectories of individual regions. Although the regional studies in Maya archaeology have become more common in the last decade, this is the first study that compares the northern and southern lowlands, spatially and temporally, and includes different factors and perspectives (climate, settlement, environment, and written sources).

The two sub-regions chosen, which represent differing environmental and cultural settings are a) the *Belize River Valley and Peten Lakes area* situated in the riverine central lowlands and b) the *Northern Yucatan Peninsula (Northern Yucatan and Quintana Roo)* in the karst northern lowlands (Fig. 2.3).

2.2.1. The Belize River Valley and Peten Lakes region

This region is situated in the central Maya lowlands, with the Belize River Valley located in present-day Belize, and the Peten Lakes area in the Peten Department in Guatemala (Fig. 2.4). The region includes a number of rivers, lakes and seasonal swamps (*bajos*). The Belize River Valley is defined by one of the largest of these rivers, the Belize River and its main tributaries, the Macal and Mopan River. The valley is divided to two topographical regions: a) The Upper Belize Valley (UBV), located west of the confluence of the Macal and Mopan rivers in the Belize Cayo district, where the alluvial plains transition to an upland area with hills and slopes rising above the rivers (Fedick 1995: 18), and b) the Central Belize Valley (CBV), where the alluvial floodplains extending from the banks of the river both to the north and the south to the low foothills, are wider (Chase and Garber 2004: 3). The rich alluvial soils along the Belize River most likely allowed these two sub-regions to become host to one of the densest ancient Maya occupations (Fedick 1995). According to Fedick (1995, 1988), prehistoric settlement patterns and organisation within the Belize River Valley is, at least to some extent, correlated with differences in soil quality distribution.

The Peten Lakes region is located approximately 100km to the west of the Belize River Valley, in the Central Peten region. It is formed by folded and faulted Cenozoic limestone ridges and depressions (West 1964; Sharer 1994: 36). Some of the fault depressions have filled with water, forming a chain of about fourteen east-west trending lakes. The terrain in the area, in general, is gently undulating; however, the slopes of the lakes are often quite steep (Dunning et al. 1998: 94). Fertile rendzina soils are, as is the case in the Belize River Valley, correlated with the densest settlement (Rice 1978).

In terms of climate, both the Belize River Valley and Peten Lakes region are located in the area where the rainfall rates are lower, especially in comparison to the southern lowlands. The Cayo district, encompassing both Belize River Valley sub-regions (UBV and CBV), can be relatively cool and dry, with an average precipitation 1651–2032mm a year, as opposed to more than 4000mm a year in the southeastern coastal region of Belize (National Meteorological Service of Belize, www.hydromet.gov.bz/climatology). The Peten Lakes area receives less rainfall than the Belize Valley, with annual precipitation of around 1350–1450mm a year.

The central lowlands, where the Belize River Valley and Peten Lakes sub-regions are situated, have seen some of the earliest lowland Maya occupation. For example, Cuello, Cahal Pech and Nakbe date to around 1200–1100 BC (Awe et al. 1990, 1992; Garber et al. 2004; Hammond 2001: 36; Hansen 1998, 2001, 2005). The region, including the Belize Valley, witnessed increasing occupation and monumental construction by the end of the Middle Preclassic period (900–400 B.C.) (Ashmore and Leventhal 1993; Brown 2001; LeCount et al. 2002; Neff 2008: 11). Perhaps even more important, both Belize River Valley and the Peten Lakes were still occupied during the Postclassic period (Audet 2002; Audet and Awe 2005; Aimers 2002; Hoggarth 2012; D. Rice 1976, 1986, 1988; P. Rice 1986, 1987, 2009; Rice and Rice 1980, 1981, 1982, 1984a, b, c, 1985, 1990, 2004), therefore a closer look at changes and processes over time in these areas and their responses to environmental stress is highly relevant.

2.2.2. Northern Yucatan and Northern Quintana Roo

The northern part of the Yucatan Peninsula (Fig. 2.5) is generally dry and hot with a mean annual temperature of 22–28 ^{o}C and precipitation rates that vary from 600–800mm on the west coast to 1300mm on the east coast (Lesser and Weidie 1988; Poag 2015: 19). Besides the highly variable precipitation rates, other physical conditions, such as soil thickness and distribution and water sources and access, vary greatly across the region, although they are largely defined by the geological nature of the region.

Specific regions considered in this study within the northern lowlands include the Northwest Karst Plain, the Northeast Karst Plain and Northeastern Yucatan (specifically the

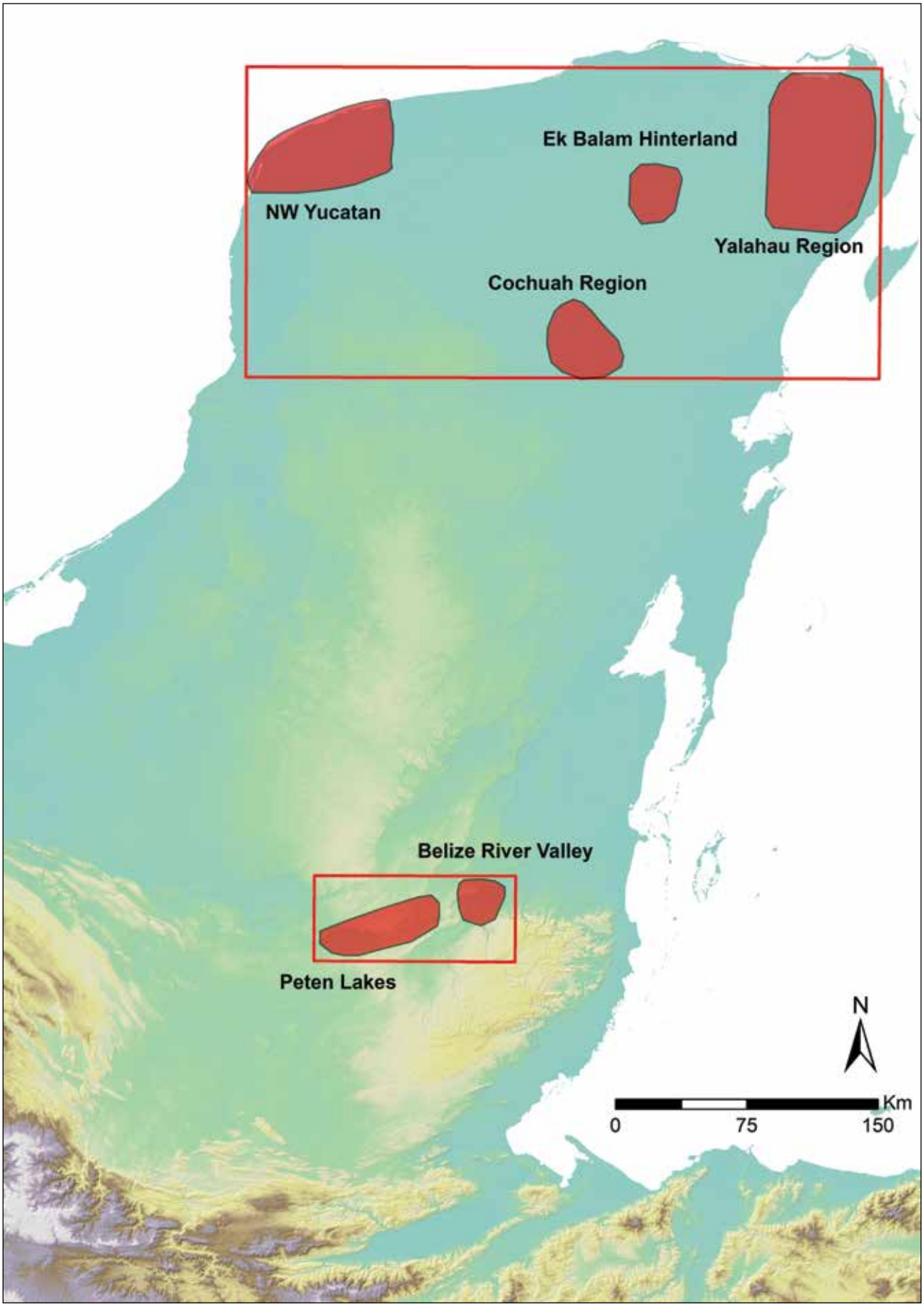


Figure 2.3. Case-study regions: a) Belize River Valley and Peten Lakes, b) Northern Yucatan Peninsula.

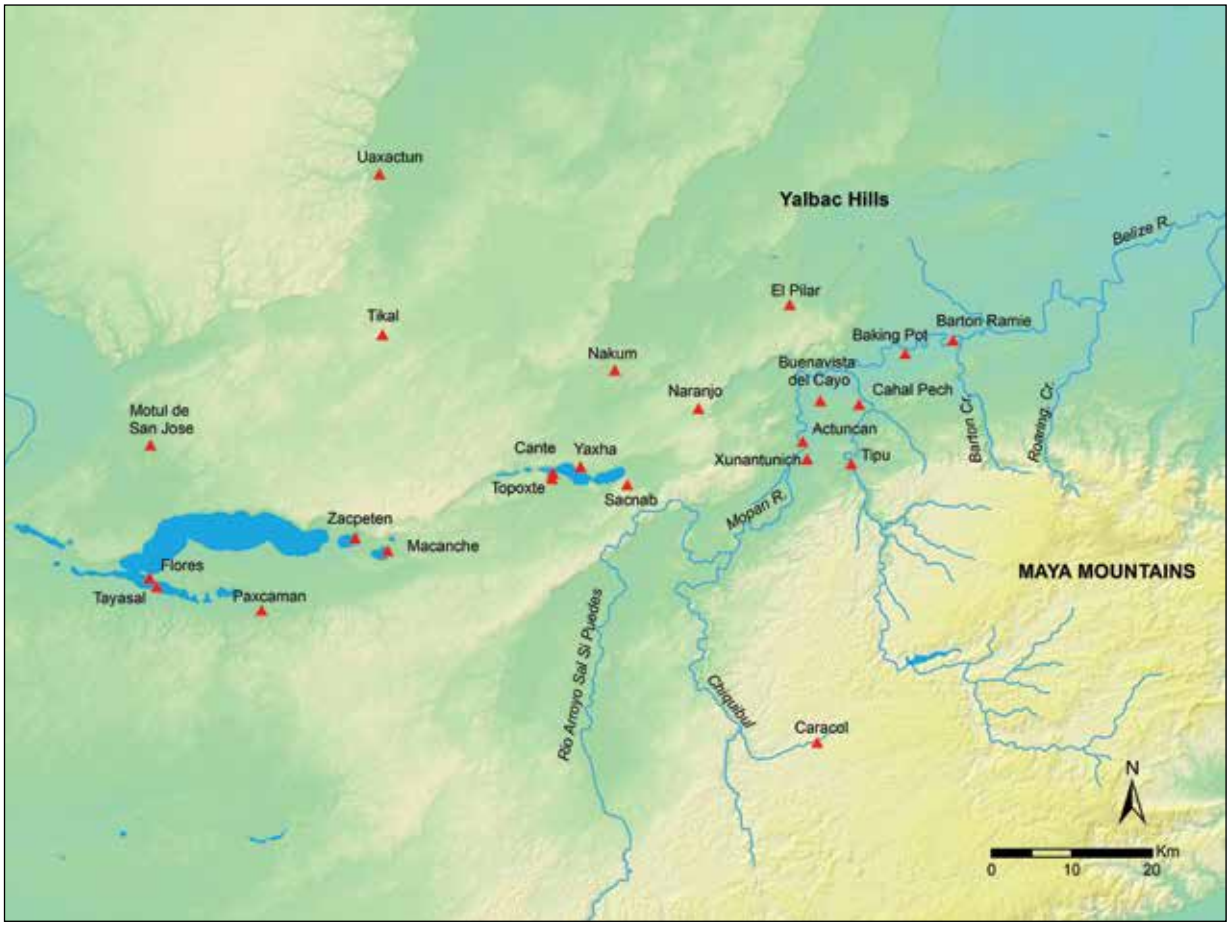


Figure 2.4. Area encompassing both the Belize River Valley and Peten Lakes regions.

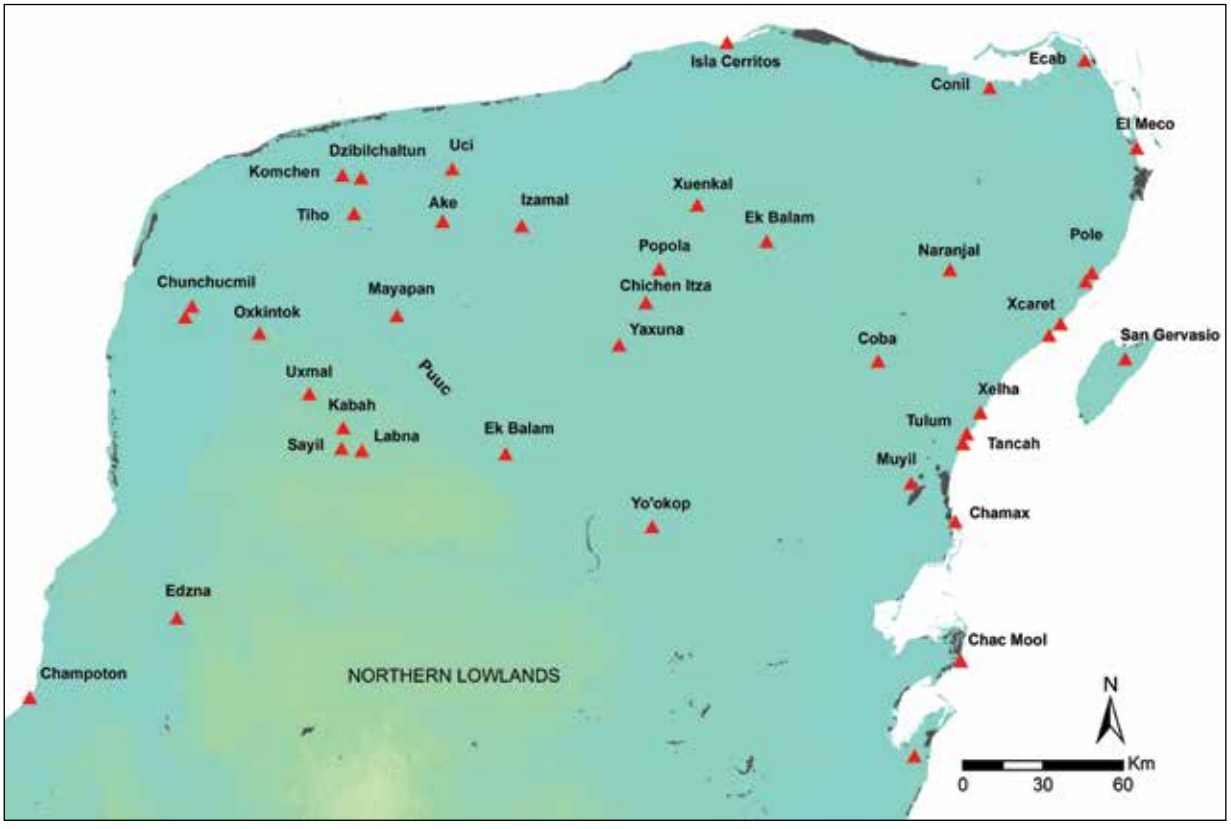


Figure 2.5. Northern Yucatan Peninsula.

Yalahau, Coba-Okop region and the northern part of the Quintana Roo depression; Fig. 2.6), following the regions of the Maya lowlands as defined by Dunning and colleagues (1998, Fig. 1). The Northwest and the Northeast Karst Plains, extending from the Puuc Hills to the coast, are flat with elevation variations from 35 to 40m, and even less variation on the coast. The Northwest and Northeast Karst Plains are also characterised by thin soils (0.5 to 1.5m deep) and by a network of underwater caves and caverns and karstic sinks (dolines) (Lesser and Weidie

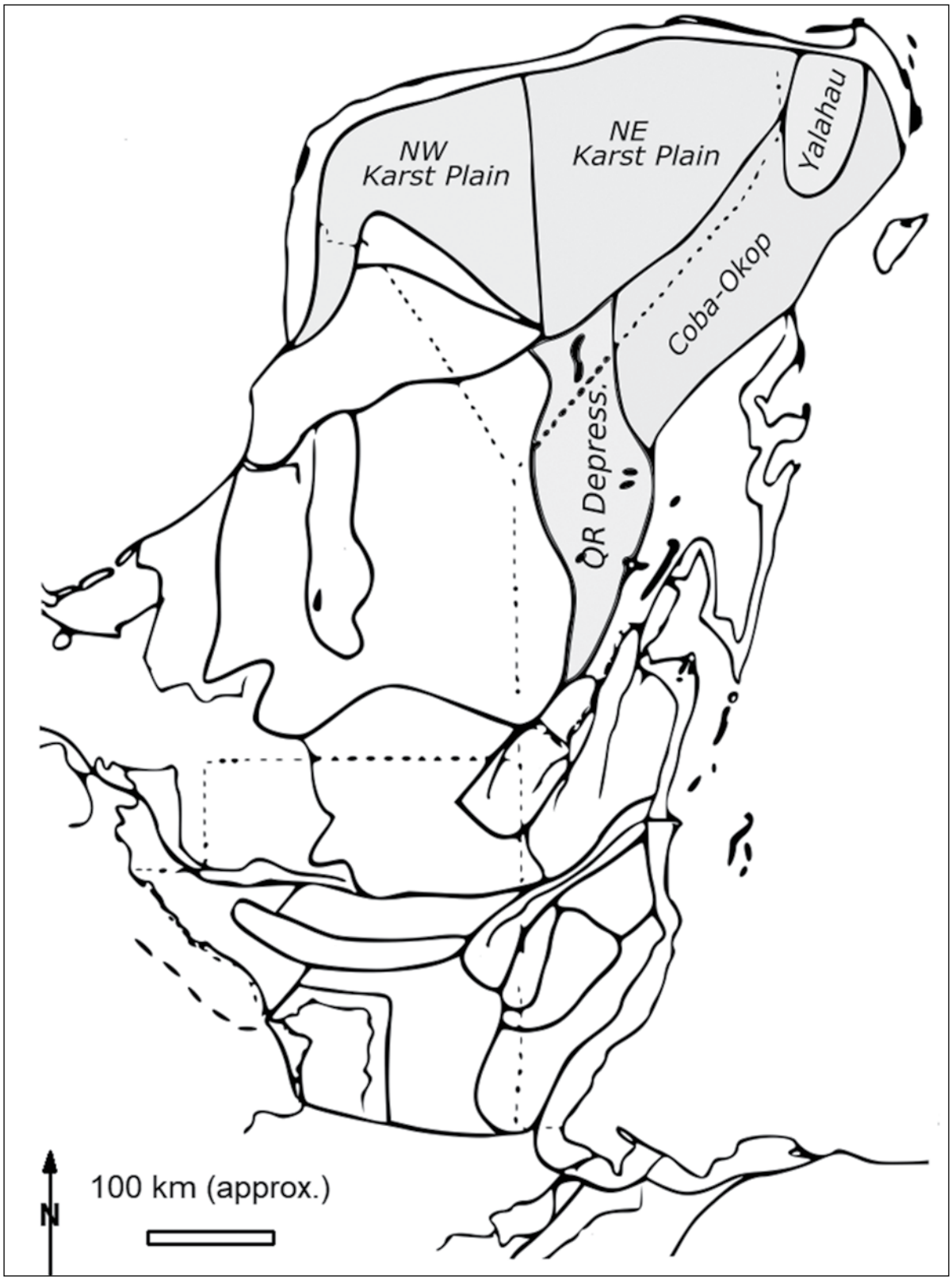


Figure 2.6. 'Adaptive' regions of the Maya Lowlands defined by Dunning and colleagues (modified from Dunning et al. 1998, Fig. 1), based on environmental conditions and type of agriculture. a) Northwest Karst Plain, b) Northeast Karst Plain, c) Yalahau, d) Coba-Okop, e) Quintana Roo Depression.

1988; Wilson 1980). It was probably the karst geology and its features, such as cenotes or sinkholes, enabling access to the watertable that made the habitation of this seemingly inhospitable region possible, a contention supported by a strong correlation between past Maya settlements and *cenotes* (Wilson 1980: 17–18). However, groundwater levels are largely affected by local precipitation, and given the very gradual drop in the groundwater table (7–10mm per kilometre), causing slow underground flow, any unusual decrease in rainfall can cause a significant drop in the watertable and problems with water access (Hodell et al. 2007: 217; Perry et al. 2002). Nevertheless, the Northern Karst Plains show surprisingly high population levels in antiquity, based on the number of archaeological sites discovered in the area, including the major centres of Dzibilchaltun, Chichen Itza, Mayapan, Ek Balam, and Yaxuna.

The Coba-Okop region runs along the eastern coast of the Yucatan Peninsula and its northern corner (Yalahau region) is characterised by linear depressions and the freshwater wetlands of the Holbox Fracture zone. Even further to the south, some of these depressions are filled by water, forming small lakes. The depressions and areas near lakes have deeper and more fertile soils, which attracted ancient settlement in these regions (Dunning et al. 1998: 92). The Quintana Roo Depression also includes basins that are flooded during the rainy season. These contain ‘deep, agriculturally challenging but fertile vertisol soils’ (Dunning et al. 1998: 92).

The Northern Yucatan region has been occupied since the Middle Preclassic period (1100/800 BC - Anderson 2003; Andrews and Robles Castellanos 2008). The region shows surprisingly dense occupation, especially considering its low agricultural potential (Beach 1998b; Dahlin et al. 2005). Furthermore, the northern lowlands became the cultural, economic and political centre of Maya civilisation after the Classic Maya ‘collapse’ and after the abandonment of many sites in the southern lowlands (Folan et al. 1983a; Demarest 2004a). In fact, there was unprecedented growth, a cultural renaissance, and population explosion on the east coast of the Peninsula in northern Quintana Roo during the Postclassic period (Andrews 1993).

3

Problematising Climate Change, Drought and Human Responses

3.1. From weather to climate, from present to past – the theoretical context

Because people are, of course, a part of the environment and constantly interact with it, they have always tried to understand their own relationship with their surroundings. However, views on how to study these human-environment interactions have changed considerably, especially during the 19th and 20th centuries.

The late 19th century concept of environmental determinism (Semple 1911, Huntington 1909, Taylor 1937), which saw environment as the determining factor in the cultural development of civilisations, was, in the early 20th century, replaced by 'possibilism' (e.g., Vidal de La Blache and Lucien Febvre in Cloke, Philo and Sadler 1991, Franz Boas, Alfred Kroeber 1939 in Bennet 1976). Possibilism focused on social conditions and saw the environment as a limiting rather than a determining factor in cultural variation. Both of these theoretical concepts failed to take into account interactions between culture/human decisions and possibilities presented by environmental conditions (Steward 1955) and the cultural ecology (Milton 1996: 43) framework was developed in order to address these shortcomings.

Conceptually, both environmental and cultural determinism treat 'culture' and 'environment' separately – as if they only affect each other externally. Cultural ecology sees the two as interdependent and seeks to study the interaction between the cultural and environmental factors (Milton 1996; Finke 2013). Steward indicated that environmental determinism and possibilism are too general, stating that they can only 'derive general principles applicable to any cultural-environmental situation'; cultural ecology differs 'in seeking to explain the origins of particular cultural features and patterns which characterise different areas' (Steward 1955: 36).

Despite Steward's efforts, his own model and models of some other cultural ecologists, such as Betty Meggers (1954), have nonetheless been seen as also environmentally deterministic, albeit in a milder form (Milton 1996). For example, Meggers (1954) in her article: 'Environmental Limitation on the Development of Culture' argues that given that subsistence depends on environment, but also seems to be responsible for the degree of development of the culture it supports; therefore 'some cause and effect relationship between environment and culture is implied' (Meggers 1954: 822). In addition, cultural ecology, with its focus on environment in terms of resources and resource practices over periods of time, has been seen as emphasising evolutionary trends at the expense of history (Wolf 1982:4; Graham 1998: 123), and dealing with effect of environment on culture, rather than people or individuals (Marquardt 1994: 204).

Eventually, these critiques led to the development of historical ecology (Crumley 1994), which focuses on human-environment interactions across both space and time, usually over long periods of time (centuries) to understand the cumulative effects of these interactions and thus incorporating historical, evolutionary and cultural dimensions of landscapes and societies (Baleé 1998). As put by Graham (1998: 125), while cultural ecology has attempted to integrate the realms of nature and society, historical ecology has the potential to integrate meaning – what people say they do and why. By embracing contradictions, historical ecology enables us to 'move more freely among the three realms' (Graham 1998: 125). However, by combining temporal and spatial histories, historical ecology requires long-term data series from diverse fields. One of the subjects historical ecologists focus on is the human experience of climate and climate change (Crumley 1994). Closely tied to this topic is also the concept of resilience; a theoretical approach which has been recently gaining popularity in Maya archaeology, especially in the context of the Classic Maya collapse. Although I do not focus on the topic of collapse, the concept of resilience is closely linked to human interactions with environment and adaptability. Resilience as a concept was first introduced in 1973 by Holling, who argued for a close link and coevolution between humans and nature, and saw them as one 'social-ecological' system (Folke 2010). He also criticised the assumption that 'systems respond to change in a linear—and therefore predictable—fashion'. As explained by Carl Folke (2010):

> 'resilience is the capacity of a system—be it an individual, a forest, a city, or an economy—to deal with change and continue to develop. It is both about withstanding shocks and disturbances (like climate change or financial crisis) and using such events to catalyze renewal, novelty, and innovation. In human systems, resilience thinking emphasizes learning and social diversity. And at the level of the biosphere, it focuses on the interdependence of people and nature, the dynamic interplay of slow and gradual change. Resilience, above all, is about turning crisis into opportunity'. http://seedmagazine.com/content/article/on resilience/

Furthermore, as observed by Walker and Salt (2006: 163) the 'capacity … to manage resilience … to avoid crossing into an undesirable system regime or to succeed in crossing into a desirable one' is referred to as 'adaptability'. Many of the discussions about resilience theory include an idea that the developmental cycles of both ecological and social systems are characterised by four ideal phases; growth (r), conservation (k), release (Ω) and reorganisation (α) (Holling 1986, Gunderson and Holling 2002; Holling and Gunderson 2002: 32–33; Berkes, Colding, and Folke 2003:16–21, Fig. 1.2, Redman 2005; Redman, Nelson, and Kinzig 2009; Walker and Salt 2006: 80, Iannone 2014). The initial r stage is characterised by exploitation of resources, rapid growth of population, use of new subsistence strategies and technologies. The following k phase consists of conservation and consolidation of resources, intensification of production and high level of integration, however growth is slower and energy invested in the system is only to keep up with expenditures rather than to expand the system. The Ω stage is rapid and represented by release of resources, disintegration of the system, declining construction and abandonment. It is followed by a phase of reorganisation, restructuring, mobility and increased diversity (Walker and Salt 2006, Iannone 2014). During reorganisation, the system might be simply reset, resembling the previous cycle, or it can have a completely different structure and new characteristics and thus an unpredictable trajectory (Redman 2005: 73, Allen et al. 2014). The Panarchy framework, closely related to the concept of adaptive cycles, suggests various degrees of connectedness between adaptive cycles of varying size (from the household size to the empire), and therefore the potential of processes at one scale to influence processes at other scales (Gunderson and Holling 2002; Holling and Gunderson 2002; Redman 2005; Walker and Salt 2006, Iannone 2014).

More recently, there have been suggestions that to understand the interactions between humans and the environment, the emphasis on long-term processes, especially concerning climate change, might not be enough, and research should be focused on recording human responses to short-term changes in addition to the traditional focus on long-term changes in climate.

Toby Pillat (2012: 33) noted that 'There is still a question whether we, as archaeologists, can ever reconcile our diverse data sets and imprecise chronologies with detailed studies of how humans encountered the climate changes of the past. I would argue that, to start tackling these issues, we need to think less about climate and more about weather'. He goes on to say that we should be trying to see the manifestation of human-environment relationships 'not in the aggregated abstractions of climate and climate change, but in the immediate experiences of weather' (Pilatt 2012: 33). To 'think about what changing weather actually meant to people in the past, and how that relates to the scientific reconstructions of climate and climate change … the role of weather cannot just be reduced to single events or long-term climatic trends. It was felt, experienced and responded to on a day-to-day basis' (Pilatt 2012: 40).

In response to the article, many researchers pointed out that in the majority of archaeological investigations, including responses to weather remains wishful thinking and is limited to periods with texts or to single extreme events which may, or may not, be part of longer climatic trends (Bell 2012: 43; Gronenborn 2012: 56) or that archaeologists must extrapolate from ethnographic observations. While knowledge of responses to changing weather conditions is, admittedly, difficult to acquire, even if we do not have the texts available, a great deal can be gained by working with different timescales and thus attempt to detect interactions between people and weather, and climate and society. For example, Cooper (2012) raised a point of importance regarding social memory (how long have particular weather events been remembered, based on the scale of their impact) and the associated accumulation of ecological knowledge, which can then be passed on from generation to generation over hundreds of years (Cooper 2012: 49). Cooper's own project, '*Archaeology of the Climate Change in the Carribean*' (Cooper and Peros 2010) shows how people's experience of weather events can be contextualized and related to longer term-climatic variability.

In Chapters 5 to 8, I discuss proxy data that indicate long-term changes in rainfall patterns, and explore the relationship between environmental/climate changes and the potential effects they have had on settlement patterns, agricultural strategies and water management, but also on religious beliefs and cultural histories in general over a long period of time (approximately 900 BC–AD 1600 for settlement patterns; AD 250–1600 for cultural histories based on written records). Before looking at the long-term climatological, archaeological and epigraphic datasets, however, in an attempt to study how humans interacted and dealt with environmental/climate change in the past, we have to understand that it is not climate change *per se* (see definition below) to which people respond; people respond instead to weather or other short-term environmental changes (Pillat 2012). If these changes persist or regularise, communities create new patterns of adjustment and eventually can be said (by us, years later) to have *adapted* to climate change (Elizabeth Graham pers. comm. 2016). Therefore, in Chapter 4 I focus attention on changes to which people respond: changes in rainfall, temperature, short-term climatic events, such as drought, floods, and hurricanes. I examine immediate experiences of variations in weather; how variations are perceived, experienced, interpreted and responded to by individuals on a day-to-day basis, but also how change is remembered on a longer-term scale and thus affects cultural patterns. These data derive from ethnographic fieldwork conducted among present-day Maya communities in Belize (Downey and Jobbová 2011), during which Sean Downey and I interviewed people about historical climate variability, drought, and adjustments to changing weather patterns.

The understanding we gained concerning the choices people made in the face of environmental stress and how individuals responded to stresses on a daily, but also longer-term, basis served as a critical guide in the exploration of the long-term climatological and archaeological datasets. In addition, extending my research to epigraphic data provided further insight into short-term responses to environmental stress. Observations from the interviews are used to determine whether any of the patterns observed during the ethnographic research are present not only in the written record but in archaeological data. Finally, the ethnographic data are used as a sort of bridge connecting the four conceptual data realms: palaeoclimatic data, settlement, subsistence and water management, and epigraphic data and connecting the present with the past. Another concept tying these four realms together are three properties, which according to Holling and Gunderson (2002: 32–33), play a key role in human response to environmental stress: (1) 'the potential available for change, since that determines the range of options possible'; (2) 'the degree of connectedness between internal controlling variables and processes, a measure that reflects the degree of flexibility or rigidity of such controls'; and (3) 'the resilience of the system, a measure of vulnerability to unexpected or unpredictable shocks'.

The rest of this chapter focuses on the four data realms separately; it explores factors affecting the data within each realm and the ways the changes in settlement patterns, subsistence and water management and written records could indicate environmental stresses and potential human responses to them.

3.2. Examining human-environment relationships in the Maya lowlands

3.2.1. Climate impact: *Regional patterns*

In the early 20th century, it was assumed that the Holocene climate did not vary much; this view started to change significantly at the end of the century (Brenner et al. 2003). The development of more sophisticated methods of reconstructing past climate also led to an increased number of palaeoenvironmental studies on the Yucatan Peninsula. These studies indicate considerable change in climate conditions, especially in rainfall patterns, during the mid- to late Holocene (deMenocal et al. 2001; Brenner et al. 2003; Leyden 2002; Rosenmeier et al. 2002a). There are records of regional oscillations between wetter and drier periods related to the migration of the Intertropical Convergence Zone (ITCZ) and also more short-term seasonal variation due to the North Atlantic Oscillation (NAO) and El Niño-Southern Oscillation (ENSO) events (Haug et al. 2001; Hodell et al. 2005a). Moreover, the increasing temporal resolution and greater spatial coverage of these records opened up possibilities to compare the palaeoclimatic data with archaeological data, and to further explore interrelationships between climate and human behaviour.

In Maya archaeology, environmental and climate change were increasingly linked to processes, such as social and political transformations, human migrations, change of settlement patterns and site abandonments (e.g., Hodell et al. 1995a, 2001, 2007; Gunn et al. 1995; Curtis et al. 1996, 1998; Lucero 2002; Haug et al. 2003; Shaw 2003; Webster et al. 2007; Kennett et al. 2012; Guenter 2014). Some of the most contested topics in Maya archaeology include, of course, the relationship between climate change and the Classic Maya collapse, but also earlier changes, such as the first intensification of agriculture and the Preclassic abandonment (e.g., Beach et al. 2009; Luzzadder-Beach et al. 2012; Shaw 2008; Douglas et al. 2015b).

One of the most important aspects of climate change is the change in precipitation patterns and, by extension, the availability of water, both for basic human needs and for agriculture, and water management (i.e., flood and drought mitigation). Although availability of water in humid tropical environments is assumed, the local environments of many regions of the Maya area have less than ideal conditions, both in terms of access to water and agriculture. This is due to hydrological conditions (depth of water table, for instance) and soil processes. Rainfall patterns in the humid tropics are also highly variable (e.g., Williams 1976; Enfield and Alfaro 1999). Spatial and seasonal variability in precipitation across the Yucatan Peninsula is high. It is linked with climatic variability of Pacific as well as Atlantic origin (ENSO and NAO, respectively). ENSO is seen as the largest driving force of climate variability in the tropics (Hastenrath 1984, 1991; Waylen et al. 1996; Poveda et al. 2006; but contra see Hunt and Elliot 2005; Giannini et al. 2000, 2001; or Poveda et al. 2006). The annual weather cycle in Yucatan is closely related to the position of the ITCZ and the North Atlantic subtropical high-pressure system (also known as the Azora-Bermuda high and part of the NAO): the northerly shifts of these systems coincide with the rainy season and their southward shifts with the dry season and reduction in rainfall (Hastenrath 1984, 1991; Gray 1993). The ENSO and NAO in general can also affect both the onset and termination of the rainy season. For example, the slower than usual northwards movement of the ITCZ during El Niño years can delay the start of the wet season (Mesoamerica Climate Outlook Forum 1998). The surface sea temperature (SST) of the North Atlantic can also have an effect on the dates of the rainy season: a warmer North Atlantic leads to an extended rainy season (with an earlier start and a delayed end) and a cooler North Atlantic usually leads to a shorter rainy season. Additionally, the end date of the rainy season, but not its start, can also be influenced by the Pacific ENSO (Enfield and Alfaro 1999; Yaeger and Hodell 2008).

As discussed in the previous chapter, most of the northern Yucatan Peninsula receives very little rainfall and, as such, was considered as barely suitable for agriculture (e.g., Yaeger and Hodell 2008, but see discussion in Chapter 7. Furthermore, the majority of rainfall, both in the northern and southern lowlands, occurs during the months of May/

June to October/November, which makes the timing of the rainy season, especially the onset, all the more important for the agricultural cycle. Ancient Maya agriculture was largely rain-fed (although there is some evidence of the existence of irrigation, e.g., Wyatt 2005: 18, 2009), as such, receiving the right amount of rainfall at the right time of the year was important. In other words, a sufficient total amount of rainfall in the year might not be enough if it rained at the wrong time. This is especially the case for the slash-and-burn type of agriculture most widely practised in the Maya area (both in the past, although see discussion in Chapter 7, and in many communities today).

The normal slash-and-burn cycle (also known as swidden or shifting cultivation) starts in January with the clearance (slashing) of vegetation. By March, the plant remains left on the field are sufficiently dry to be burned; and the planting of the corn would ideally begin in mid-April. If the timing of the rains is right, this single crop is sufficient for the year. Elaborate corncribs used to be built inside the house to store and protect the crop after harvesting (less common today). However, if the rain comes too early, the plant remains will not be properly dried for the subsequent burning of the field, which in turn means the fields will not be fertilised with the ash. A late onset of the rainy season is also problematic. The latest point that corn can be planted is the end of June. If the corn stalks do not have enough time to mature enough, they will be broken and flattened to the ground by the heavy rains. If the spring crop fails completely, it is possible to plant a second crop in the late fall, usually in November (Downey and Jobbová 2011).

High seasonal variability in rainfall is, therefore, a distinct disadvantage. Unfortunately, with the current chronological resolutions offered by palaeoclimatic proxies, it is impossible to assess seasonal variability of rainfall for those periods before direct measurement of precipitation began, which for Maya region is only slightly more than 100 years ago. Inter-annual variability of rainfall, however, can be inferred with some degree of certainty from long-term palaeoclimatic proxies (discussed in Chapter 5). For example, Akers and colleagues (2016), based on a new palaeoclimatic record derived from a stalagmite extracted from the cave on the northern Vaca Plateau in Belize, emphasised importance of the abnormally low variability of rainfall between the Late Preclassic and Middle Classic period for the flourishing of the Classic Maya society and argue that 'the Maya were not typically limited by average precipitation amount as much as precipitation variability. A resilient Maya society could adapt to reduced precipitation by changes in landscape modification and agricultural practices, but adapting to and planning for increased climate variability would be much more difficult' (2016: 285).

The vulnerability of Maya agriculture caused by high seasonal variability of rainfall is exacerbated in the neotropical environment by problems with long-term storage (Guenter 2014; Kennet and Beach 2014). Although the Maya used several methods of storing food, such as pits cut into the ground called *chultuns* (Freidel and Shaw 2000: 289), salting and smoking (Andrews 1983: 10; Graham 1994; Landa 1982 [1560]: 121), and also, possibly, storage in structures where springs running through them kept temperatures uniform (Wyatt 2005, 2009, although this seems to be more of an exception). Nevertheless, these methods can only preserve food for a limited time (maximum three years – Freidel and Shaw 2000: 289; Guenter 2014: 270) and in the case of crops, after just two years of unsuccessful planting or poor harvest, there would be no seeds left to plant. Considering the heavy reliance of the Maya on the three main crops of maize, squash and beans, this could have severe consequences. Although the Maya had few domesticated animals (dogs and turkeys), one of the subsistence strategies they could fall back on was hunting, fishing and gathering of food from the forest (e.g., Farriss 1984: 72–79; Ford 2008; Ford and Nigh 2009), also discussed in more detail in Chapter 4. As argued, for example by Guenter (2014: 273), this might have become more difficult with increasing population and extensive deforestation recorded from the Middle Preclassic through the Late Classic (Deevey et al. 1978, 1979; Curtis et al. 1996; Anselmetti et al. 2007; Wahl et al. 2006; Cook et al. 2012).

Another coping strategy, which many have suggested may have developed as a result of drying conditions or deforestation, is the intensification and diversification of agriculture and water management at the end of the Late Preclassic period (Tainter 1988, 2000; Douglas et al. 2015b; Turner 1974; Beach and Dunning 1995; Beach et al. 2002; Kennett and Beach 2014). This hypothesis is discussed in more detail below and in Chapter 7. It has been argued that, apart from agricultural and water management strategies, climate variability also had an impact on settlement patterns and socio-political complexity (discussed below and in Chapters 6 and 8).

Climate impact: local environmental effects

The impact of spatial and seasonal variability in precipitation differed significantly from locale to locale in the region. Yaeger and Hodell (2008), for example, argue that in regions, like the northern lowlands with average annual rainfall barely sufficient for maize production, any reduction in precipitation, especially during the dry season, could have a significant effect. On the other hand, in areas with an annual precipitation rate that is higher than needed for maize agriculture, such as the southern or central lowlands, a reduction in precipitation, especially during the rainy season, would have little impact. Increased rainfall would have no effect at all, as the excess precipitation does not increase crop yields (Yaeger and Hodell 2008, but see discussion in Chapter 9). The relative dryness of the northern lowlands is often used to argue that if drought had played a significant role in the Classic Maya collapse, the northern lowlands would have been abandoned before their southern counterparts, as they would have been more vulnerable to drought. Similar arguments have been presented in regard to the geological conditions and related access to water. The Northern Yucatan Peninsula, with its

karst landscape, is perceived as region without surface water, with water often accessible only with difficulties from sinkholes and wells. In comparison, the southern lowlands, with a very different geology and morphology, retains the water from the mountains in rivers and lakes (Folan et al. 1983a). These arguments, however, do not take into account that the northern lowlands may have an advantage in lower seasonal variability and perhaps in the use of more variable agricultural and economic strategies, while higher seasonal variability, especially in the central/western lowlands, might have played an important role. Similarly, the much shallower water table in the northern lowlands can be reached either through sinkholes and *cenotes*, or through wells. On the contrary, some areas in the central lowlands not only lack surface water but the water table is too deep to be accessed through wells.

When assessing the impact of changing rainfall patterns on the Maya civilisation, it is therefore crucial to use palaeoclimatic data that is as geographically relevant as possible, and to consider the environmental settings of the individual regions. The same applies to non-environmental factors, such as occupation densities, socio-cultural complexity, and the role of Maya rulers and elites (agency, e.g., Webster 2002) and non-elites/commoners (Farris 1984), discussed below. Use of regional proxy data is even more important because of problems with temporal resolutions of palaeoclimatic data and because most palaeoclimate records reflect localised climate conditions. Even the comparison between theoretically comparable proxy datasets, such as oxygen isotope ratios in sediments from different lakes, can be complicated. Not only do depositional processes in different lakes vary, but also 'annual resolution in a palaeoclimate record doesn't necessarily imply annual accuracy, because some chronologies are not anchored securely in time' (Aimers and Hodell 2011: 45). The absolute dating of these sediment records, usually by AMS C14 dating is not precise. For example, it is estimated that the dating for Lake Chichancanab is off by ± 90 to 130 years (Hodell et al. 2005: 1423). On the other hand, for records such as annually banded speleothem, dated by more precise uranium thorium dating, this error can be reduced to ± 5 years. Therefore, while regional trends can be detected, comparison between the regions and sometimes also between individual proxies from the same region, especially if they were dated by different methods, can be less secure (Leyden 2002). In the course of this study, therefore, whenever I compare palaeoclimatic data and either archaeological or epigraphic data, I endeavour to use proxies from as geographically close a region as possible.

3.2.2. Settlement survey evidence

It has been said that '[t]he distinctiveness of the relationship the ancient Maya had with their environment is revealed nowhere more strongly than in their settlement patterns' (Puleston 1982: 363). The concept of settlement pattern studies developed in the late 19th century. Settlement pattern studies analyse how people were distributed across the landscape, and how these distributions reflect relationships and interactions between humans and the environment and also among humans themselves (Willey et al. 1965: 5; Ashmore and Willey 1981: 3–4).

True cities, vacant ceremonial centres?

Some of the questions that stimulated the study of settlement patterns in the Maya area were concerned with the nature of ancient Maya cities and their urbanism, as well as Maya socio-political organisation (Kurjack 1974: 5). The early references to Maya 'cities' and their multiple functional nature, including religious, economic, residential – as for example proposed by John Loyd Stephens [1841, vol. II: 355–356]) – were challenged. Lewis Henry Morgan, an American anthropologist and social theorist, suggested that instead of Stephens's 'true cities', the Maya lived in small village communities, similar to the pueblo-like residential clusters of the Native Americans in the United States (Brown and Witschey 2001: 3). Morgan argued that: 'considering the space now occupied by the ruins as the site of palaces, temples, and public buildings, and supposing the houses of the inhabitants…, to have disappeared altogether, the city might have covered an immense extent. This is a clear case of suggestion falsi by Mr. Stephens… He had fallen into the mistake of regarding these remains as a city in ruins, instead of a small Indian pueblo in ruins' (Morgan 1881: 271).

Morgan's view was refuted by settlement studies conducted at several Maya sites. For example, Edward Thompson (1886, 1892), working at Maya sites in Yucatan, observed many small mounds at these centres and, based on their abundance, similarity to modern Maya dwellings, and the domestic nature of artefacts found in them, he identified them as the remains of ancient Maya houses. Thompson's observations were also important because it was the first time that attention was focused on the residential element of occupation, rather than on the monumental architecture (Ashmore and Willey 1981: 6). Thompson's observation was soon supported by other archaeologists, who began to recognise and examine the small residential mounds at Maya sites. George Gordon (1896) noticed small mounds around Copan, Edgar Hewett (1912) at Quirigua, and Alfred Tozzer (1913) found small mounds along the trails between sites in Peten. Although these observations were recorded, archaeological interest in the early 20th century remained almost exclusively in the monumental epicentres of the sites, focusing on monumental architecture, art and hieroglyphic inscriptions.

There were some early exceptions, such as the work by Lothrop (1924) examining the structural density and distribution of house mounds at Tulum, or Joyce (1928) conducting excavations at some of the small mounds at Pusilhá. In the 1930s, settlement studies became more common and brought new methodological approaches. For example, Smith's (1936a, 1936b) development of the ceramic chronological sequence at Uaxactun added the possibility of looking at chronological sequences within studies of spatial distributions. The first systematic

study of house mounds carried out by the Ricketsons at Uaxactun led to estimates of Uaxactun's population during the Classic period (Ricketson and Ricketson 1937). The result they obtained was 270.83 people per square mile, or 48,500 inhabitants for the Uaxactun district. This was then used in an attempt to calculate the population of the entire Yucatan Peninsula, arriving at the figure of about 13 million people (Ricketson and Ricketson 1937: 16–286). Whether these figures were underestimates or not, and despite the fact that population estimates remain one of the most debated topics in Maya archaeology, the Ricketsons were the first researchers to attempt to use settlement data to address questions of ancient Maya demography. In addition, studies such as those by Kidder (1937), Thompson (1931), and Wauchope (1934, 1938), stressed the importance of ethnographic research and use of ethnographic analogies (although the use of direct ethnographic analogies has sometimes been criticised [e.g., Ochoa-Winemiller 2004]). Surprisingly, even with these early insights gained from settlement studies, the 'vacant ceremonial centre' view dominated Maya studies until the late 1960s. Classic Maya society was perceived to be a peaceful theocracy run by priests, and their cities were 'religious centres to which the Maya resorted only for ceremonies' (Morley and Brainerd 1956: 261).

Peopling the land: Implications of settlement studies on Maya archaeology

Steward and Setzler (1938) and Taylor (1948) were scholars who emphasised the role of people and their behaviour within society, an emphasis that affected the focus and questions being asked by archaeologists when conducting settlement studies. Steward saw the opportunity to use settlement pattern analyses to address questions about social organisation, subsistence strategies, and cultural adaptation of humans to the environment in a specific area. This eventually resulted in Steward convincing Gordon Willey to use a settlement approach at Virú Valley in Peru in 1946. Willey conducted a settlement survey and coined the term *settlement pattern* in the archaeological literature (Ashmore and Willey 1981: 10), even though initially he was less than convinced of the approach. Willey commented that while his colleagues 'were getting tangible pottery sequences to the delight of any self-respecting archaeologist… I was chasing some kind of wraith called 'settlement patterns' that had been dreamed up by a social anthropologist' (Willey 1974: 154). Despite his initial misgivings, Willey's Virú Valley project had a major impact on the future development of archaeology in general and also on Maya archaeology specifically. After the Virú Valley project, Willey shifted his focus to the Maya lowlands, starting with a settlement project at the site of Baton Ramie in the Belize River Valley (Willey et al. 1965), and later continuing at several other sites, such as Seibal, Altar de Sacrificios, and Copan Valley. Other researchers also started to collect settlement data across the Maya lowlands. One of the Willey's graduate students, William Bullard (1960), conducted a settlement survey in the northeastern Peten. He looked at hierarchy in the settlement and introduced such concepts as the '*major* and *minor ceremonial center'* and the '*household cluster'* (Ashmore and Willey 1981: 13). Other projects followed: Sanders's at Quintana Roo (1955a, b, 1960); the Carnegie Institution's project at Mayapan; the large-scale projects of the University of Pennsylvania at Tikal (Haviland 1965, 1966, 1969, 1970, 1981, 1982); and the Dzibilchaltun project in northwestern Yucatan (Andrews IV 1965a, b).

Such an explosion of settlement studies brought significant changes to Maya archaeology. The above-mentioned projects provided large amounts of data, fuelling numerous debates. Some archaeologists, in fact, started to worry that Maya archaeology had begun to rely too heavily on survey and surface collection data, neglecting excavations. Hendon (1992: 37) argued that: '[f]or reasons largely unrelated to matters of archaeological theory, namely issues of funding, preservation, and time, we have been tempted to attribute a greater degree of precision to surface-derived data than is warranted.' This statement neglected the fact that Willey's work at Barton Ramie consisted, to a large degree, of excavations. Others pointed out the methodological and analytical limitations of the settlement pattern approach (e.g., Trigger 1967). Despite the criticism, settlement archaeology continued gaining popularity, and after the mid-60s, partly influenced by the growth of processual archaeology, it became more diverse, but at the same time, more focused on specific problems and research questions (Ashmore and Willey 1981: 16). Most importantly, insights gained from settlement pattern studies and the application of new methods to carry out surveys and analyse results (e.g., new sampling techniques, large-scale settlement surveys, study of subsistence strategies) significantly changed the understanding of many aspects of Maya culture. Estimates of population, settlement densities and, in some cases, even urban proportions of Maya settlement, did not support the 'vacant ceremonial centres' view; neither could they any longer accommodate previous assumptions of swidden agriculture as the main subsistence strategy (Ricketson and Ricketson 1937; Harrison and Turner 1978; Sanders 1979; Adams 1980; Siemens 1982; Lohse 2004). This was emphasised further by the relatively recent focus of settlement analysis on 'off-site' surveys, where research extends to features, such as agricultural terraces, field systems, *aguadas* and quarries (especially with the growing use of LiDAR technology). Furthermore, large-scale surveys and the examination of the relationships between individual centres, in some cases with added insights from hieroglyphic texts (e.g., Marcus 1976), attempted to answer questions about socio-political hierarchies and organisation (Willey and Smith 1969; Hammond 1974; Puleston 1974; Ashmore and Sharer 1978). Now, settlement studies are a part of most projects, albeit to different degrees.

All of this leads us to the question: In what ways can examining settlement patterns inform us about climate stress and human responses to stress? We will turn to this now.

Factors influencing settlement patterns

Settlements, their locations, size, internal organisation and wider spatial distribution, as well as how these characteristics change through time, are determined and affected by many different factors, related both to the environment and to human society. In order to be able to recognise and interpret the factors behind changes in ancient Maya settlements, it is important to first understand their nature and the ways in which they affect settlement patterns.

Ecological/environmental factors: Traditional views perceived environmental factors as the main drivers behind human decisions about the settlement location. Factors such as topography, geology or climate are directly linked to access to water, soils suitable for agriculture, temperature and rainfall patterns, all of which have bearing on where settlements are located and, to some extent, also how they are distributed. Water and food are the essential resources, therefore, it is not surprising that settlements are generally associated with permanent water sources and good agricultural land. Many large and successful Maya sites are located along major rivers, which were not only sources of water and fertile alluvial soils, but also functioned as communication and trade routes (Sharer 2009: 188). Besides the banks of rivers, many Maya lowlands sites are located close to *bajos* that provided water but also played important role in agricultural intensification (discussed in detail in Chapter 7) (Dunning et al. 2002; Luzzadder-Beach et al. 2012; Beach and Luzzadder-Beach 2013; Kennett and Beach 2014). Settlement location can be also affected by access to material resources, such as chert, obsidian, jade, or salt.

With the increasing amount of palaeoclimatic data collected in the last two decades, indicating considerable changes in rainfall patterns during the mid- to late Holocene (Brenner et al. 2002; Hillesheim et al. 2005; Hodell et al. 1995a, 2005, 2007; Leyden 2002; Rosenmeier et al. 2002; Wanner et al. 2008; Webster et al. 2007; Kennett et al. 2012), some studies have started to look at possible correlations between climate patterns and the growth and decline of the Maya civilisation in general, as well as population movement and settlement shifts in particular. For example, Folan and others have argued that the movement in population concentrations from inland to coastal areas and back can be explained by variation in rainfall patterns (1978); similar explanations can be offered for shifts in power among the major Maya centres (Folan 1977, 1980; Folan et al. 1983b; Kurjack and Garza 1981). On a more local scale, Shaw explored the shifts in the Late to Terminal Classic settlement patterns in Yo'okop in order to see if these reflect water scarcity (Shaw 2005, 2008). All of these studies, to a certain degree, touch on one of the most debated topics in Maya archaeology: that a series of severe droughts, both at the end of the Preclassic period and especially during the Terminal Classic period, was the main cause of the Late Preclassic abandonment and the Classic Maya collapse (Gill 1994, 2000; Hodell et al. 1995a, 2001, 2007; Gunn et al. 1995; Curtis et al. 1996, 1998; Lucero 2002; Haug et al. 2003; Shaw 2003; Webster et al. 2007; Kennett et al. 2012; Guenter 2014).

Although changes in rainfall might have a direct effect on settlements in extreme cases, it more commonly influences settlements through adaptations in subsistence and water management strategies (which then in turn have an effect on settlement patterns). For example, periods with diminished precipitation have been linked with development of wetland agriculture and associated settlement changes, such as occupying places with reliable water sources, including seasonal and perennial wetlands (e.g., Douglas et al. 2015b; Luzzadder-Beach et al. 2012; Beach et al. 2009). Furthermore, Drennan (1988) has suggested that the intensification of Maya agriculture, such as utilising wetlands, raised fields or terracing, might have led to a dispersed settlement pattern because families needed to stay close to their fields. On the other hand, settlement densities of other Mesoamerican cities, such as Teotihuacan or Tula (5000–7500/km^2, Smith 2001: 29) or Tenochtitlan (15,000/km^2, Smith 2001: 292, although this has been questioned – Evans 2013: 549), which relied on intensive agriculture (raised fields or *chinampas*, although they must have imported food as well) do not support such a hypothesis. The settlement densities of other sites, such as Mayapan (17 000/9–10km^2) and Chunchucmil (35–43 000/20–25km^2) (Russell 2008: iii; Magnoni: 2008; Magnoni et al. 2012: 315) also do not support the notion that intensification of agriculture leads to a dispersed population. These sites are located in dry areas with little rainfall and very thin soils, not favourable for extensive agriculture, and thus were most likely relying on intensive agricultural strategies, using features such as *dzadzes* and *rejolladas*[1] (although probably subsidised by importing food and non-agricultural economies, such as fishing and salt production, discussed in more detail in Chapter 7). In contrast, Tikal, most likely reliant on extensive agriculture to a larger degree, had a relatively low settlement density (circa 500/km^2: Smith 2001: 292)[2]. Changes in agricultural and water management strategies will be further discussed in Chapter 7.

Settlement pattern changes have been also linked to the shift from the mainly agriculture orientated economies to more variable economic and subsistence strategies (Andrews 1993). For example, it was suggested that the Postclassic clustering of inland settlements around the lakes and rivers might reflect attempts at a more balanced subsistence base, reducing the impact of agricultural failure (seen as a result of a drying trend during the Terminal Classic period) (Andrews 1993). Similarly, population movement from inland regions and the growth of coastal communities, especially in the northern lowlands, indicates increased reliance on maritime resources, but also growing and

[1] *Dzadzes* and *rejolladas* are karstic depressions in the ground, used either as water sources or for agricultural purposes.

[2] For a different view on Maya population densities, suggesting that they were much smaller than has been generally proposed, see Webster 2018.

changing trade networks and salt production (Andrews 1993; Golitko et al. 2012; Golitko and Feinman 2015; McKillop 2002, 2005).

Settlement patterns are not just a reflection of the physical environment and many researchers argue for the recognition of non-environmental factors, such as social, economic, ideological and political factors. In *Prehistoric Settlement Patterns in the New World,* Gordon Willey suggested that 'settlements are a more direct reflection of social and economic activities than are most other aspects of material culture available to the archaeologist.' (1956: 1). Others have stressed the importance of political organisation and ritual and symbolic expression (Ashmore and Knapp 1999). Classic Maya social organisation and especially the concept of Maya kingship entailed politics, economy, ritual and warfare (Marcus 1993; McAnany 1993; Webster 2002; Demarest 2004a, Graham 2011).

Social and political organisation: Although Maya political organisation is still one of the most debated topics, it is evident that Maya polities functioned within hierarchical economic and socio-political networks of alliances, which changed frequently because of the cooperative and antagonistic relationships between and among these polities (Martin and Grube 1995, 2000; Helmke and Awe 2012; Munson and Macri 2009). The textual evidence indicates that the power shifts and increasingly hierarchical relationships in which one of the polities was subordinated to another became more prevalent during the Classic period, with a few polities becoming more powerful and being seen as centralised states or 'superpowers' (Marcus 1976; Chase and Chase 1996; Martin and Grube 1995, 2000). For the rulers, the means of gaining legitimacy and power within these networks was mainly through warfare and marriage, and ritual and ideology were used to justify it. The monuments, with representations of kings as warriors taking prominent captives, and the monumental architecture were all intended to display and reinforce power (Demarest 2004a; Kennett and Beach 2014). The combination of textual evidence, describing the defeat of one Maya polity by another, and archaeological evidence suggests that the defeated polity suffered both politically and economically (e.g., Graham 2011; Graham et al. 2013; Kettunen 2014). For example, there is evidence of a hiatus at both Tikal and Caracol following their defeat, during which there is a lack of construction activity and gap in erection of monuments, such as stelae commemorating the deeds of kings (e.g., Tikal hiatus, AD 562–692; Caracol hiatus, AD 680–798; Martin and Grube 2000). As argued by Graham, extracting tribute and resources from the defeated polity might have been one of the main reasons for waging wars (2011: 38–43; Graham et al. 2013; Aoyama and Graham 2015).

The above-mentioned aspects of social and political organisation affect settlement patterns in several different ways. First of all, with a growing population, settlement sizes grew as well, eventually leading to low-density urbanism (Kennett and Beach 2014; Zeder 1991). It is also often argued that increased population pressure triggered diversification and intensification of agriculture, which in turn led to use of the marginal zones not particularly suitable for agriculture (or at least, it required more work), such as wetlands or lakes (Kennett and Beach 2014; Dunning et al. 2002, 2006; Beach et al. 2009), but at the same time also to shifting and/or expanding of settlements to previously unoccupied areas.

With the increasing socio-political complexity of Maya society, the configuration of individual sites, and also their spatial distribution in relation to each other, changed over time. There is also a considerable variation among contemporary sites in terms of size, spatial organisation, and in the quantity and elaborate monumentality of its structures, usually reflecting relative economic and political power (Sharer 1994: 493). Based on the settlement survey conducted in the Belize Valley (Bullard 1960; Willey et al. 1965), the settlement hierarchy of the Belize Valley is defined by a three-tiered model consisting of major and minor ceremonial centres and residential house mound groups (Driver and Garber 2004: 287–293; Iannone 2004). Although the differences between minor and major centres, and the relative importance of individual attributes defining their status, continue to be discussed, the main attributes possessed by major centres are: nucleated monumental centres, pyramidal structures and royal palatial groups, E-groups, ballcourts, stelae and altars (some carved), processional *sacbeob* (causeways) and their termini groups, and sometimes also royal tombs (see Bullard and Bullard 1965; Awe 1992; Taschek and Ball 1999; Ball and Taschek 2004; Ford 2004; Garber et al. 2004; Healy et al. 2004b; Iannone 2004: 280–282, 2005; Leventhal and Ashmore 2004; Helmke et al. 2005; Helmke and Awe 2012: 61–65). Although there is a grey area between major and minor centres, in general the latter lack some of above listed attributes such as ballcourts, causeways, or stelae (Bullard 1960: 360; Willey and Bullard 1965: 368; Iannone 2004: 281). There can be a great disparity, especially in size, even between major centres, however, suggesting that this matter is far more complex than realised, and the function and interactions between the minor and major centres have thus been the subject of many different models. For example, in the Belize Valley, the first model was Gordon Willey's 'Territorial zones' in which major centres controlled extensive areas of agricultural land (Willey et al. 1965). Then came Thiessen polygons, which assumed politically independent centres (Ball and Taschek 1991). More complex models then developed, taking into account differences in power. Garber and colleagues proposed a model in which the majority of 'major centres' were regularly spaced approximately 9.9km apart, with minor centres located at the boundary or a point of overlap between the two major centres (4–5 km) (Garber et al. 1993; Driver and Garber 2004). Such a model suggests a pattern in which minor centres might have functioned as provincial administrative seats, managing surplus production and redistribution for the major centre (Helmke at al. 2004; Helmke and Awe

2012). This idea was revised by Helmke and Awe (2012), who built on a model proposed by Peter Mathews (1988, 1991), which was based on the hieroglyphic inscriptions and emblem glyphs in particular. Helmke and Awe (2012: 71, 81) showed that while regular spacing of major and minor centres in the Belize Valley indicates some 'underlying territorial structure', interactions revealed by a combination of epigraphic and archaeological evidence suggests a greater scale of complexity. These centres belonged to hierarchical networks that were inconsecutive and constantly changing based on interactions between individual sites.

Concentration and dispersal of political and economic power: Other models made links between nucleation of settlements and centralisation of political and economic power, and vice versa, dispersal of settlements with their decentralisation (Sabloff 1996). For example, increased nucleation and the formal settlement structure of large urban centres, such as Tikal or Caracol, but also many smaller sites, was associated with political centralisation during the Late Classic period (Sabloff 1996; Rice and Rice 1980). Similarly, the dense nucleated settlement of Mayapan in the northern lowlands was seen as being indicative of a more centralised political structure during the Late Postclassic period, a structure suggested to be related to the growth of mercantilism (Sabloff 1996). On the other hand, the decrease in monumental construction and more dispersed patterns of the Postclassic period has been seen as reflecting the possible decentralisation of Maya society and loss of economic and political power held by traditional Maya elites during the Classic period. It was also pointed out that there are significant differences in site layouts (e.g., Chunchucmil, Coba, Tikal, Caracol), suggesting that 'not all populations were administered in the same ways', and simple equating of the size of a site with the degree of political centralisation might be misleading (Hutson et al. 2008: 19). To some extent, the concept of centralisation/decentralisation is related to a unilineal evolutionary concept suggesting that 'with time, most, if not all, prehistoric settlements should eventually develop into large, nucleated, western-style, urban communities'; this assumption leads to the debate about whether Maya cities are 'real' cities because of their relatively low density (Awe et al. 2014: 274). Perhaps further insight into the centralised versus decentralised dichotomy can be gained by looking at the organisation of settlement on an intra-site scale. For example, Rice and Rice (1980) argue that if we assume that the Late Classic formal settlement structure reflects centralised and institutionalised Late Classic society, some degree of decentralisation of the Postclassic society might be suggested by the less formal Postclassic settlement structure.

Another aspect that needs to be considered when examining settlement patterns and occupation densities is the structural permanence. In Mesoamerica, structures (both masonry and wooden/pole-and-thatch) were usually built on terraced platforms, around stabilised core material and faced with cut stone; the platforms and the buildings they supported were arranged around plazas, patios or courtyards (Loten and Pendergast 1984). This is true of ceremonial, administrative and residential structures across Mesoamerica. It has been argued that the claimed decline in population after the Late Classic period was overestimated, and did not take into account perishable structures that might have replaced masonry ones (Graham 1985, 2004). Such a consideration is relevant especially in the light of a decrease in monumental construction and settlement dispersal after the Late Classic period. For example, at Lamanai, Graham noted a return to building perishable structures in the Terminal Classic period (2004: 224).

Perishable structures would still have been mostly built on platforms (although in many cases the older platforms would have been reused, e.g., at Baking Pot or Barton Ramie [Willey et al. 1968: 291], or added to [Graham 2004]). Therefore, although perishable structures would certainly be more difficult to detect archaeologically, the evidence of occupation during the Terminal and Postclassic periods (if present) could be, in many cases, still obtained through platform use and associated ceramic material. The larger problem present is that of so-called 'hidden mounds', referring to perishable structures that were not built on platforms (e.g., Wilk and Wilhite 1991: 119; Ashmore 1980; Pendergast et al. 1993; Graham 1999, 2004; D. Chase 1990; A. Chase 1990; Pyburn 1990). During a survey, these are only identifiable on the basis of artefact concentrations on the surface, and during excavations by concentrations of pebble-sized stones usually hinting at micro-platforms, or sometimes by post-holes/moulds. Although much more difficult to detect, the 'hidden mounds' are in many cases still identifiable. These were identified in Early Colonial settlements, such as Tipu, parts of Lamanai and San José (Pendergast et al. 1993), also in the Postclassic settlement in the Tayasal – Paxcaman zone (A. Chase 1976, 1990); they are particularly common at Santa Rita Corozal (25%–50%, D. Chase 1990: 201). Finally, the detection of post-Late Classic settlements might also be hampered by the dispersal of settlements, depending on the settlement survey strategy and terrain conditions.

Besides the interaction on the elite level, the political balance in the region could also be affected by commoners moving between settlements, or 'voting with their feet' as put by Farris (1984: 76), given their importance as food providers (e.g., Robin 1999: 357–359; Robin et al. 2010). Farris, exploring the movements of Maya commoners during the Colonial Period, points out their ability to move around, establish new communities if necessary, or integrate themselves into existing ones. This ability gave them a choice to react in intolerable situations, albeit by flight, temporary or permanent, which as Farris argues, 'has been the characteristic Maya response to crises' (1984: 75).

In comparison to the southern lowlands, socio-political organisation of the northern lowlands is less well understood, partly owing to the lack of hieroglyphic

texts. Traditionally, the northern lowlands have been seen as generally less centrally organised, with many sites participating in the so-called *multepal* system, or joint rule of lords holding the same status (Krochock 1998; Schele and Freidel 1990), although this has been more recently doubted, mainly by epigraphers (e.g., Boot 2007; Cobos 2000, 2007). Growing research in this region shows, however, that many aspects of social and political organisation of northern lowland polities were similar to those known from the southern lowlands. Presence of emblem glyphs and royal titles at some sites supports the existence of divine kingship and participation in hierarchical networks, in some cases, even in the same networks the cities in the south were part of (e.g., Coba belonged to the *Kaan* (Calakmul) sphere of influence - Mercier and Cottini Giroldo 2014). There is also evidence for trade, and many sites in the northern lowlands also showed signs of 'collapse' and abandonment during the Terminal Classic period.

Warfare and religion: Two more factors affecting settlement patterns should be mentioned: warfare and religion. In the power struggle within the hierarchical network of Maya polities, warfare played an important role and had political and economic consequences (Graham 2011; Aoyama and Graham 2015; Kettunen 2014). It has been also argued that warfare significantly influences settlement patterns on different scales (Brown and Witschey 2003: 1629; Ball 1977; Webster 1977; Peregrine 1993). For example, fortification of sites and increased occupation of defensible positions in the Terminal Classic period has been linked to warfare (Demarest at al. 1997; Demarest 2004b; O'Mansky and Dunning 2004). Others have argued that warfare, especially among swidden agriculturalists, might in some cases lead to settlement nucleation (Long 1968: 80; Ringle 1985: 336–339). Ringle, citing Long's (1968: 80) ethnographic observations of swidden farmers in Zambia, argues that competition for land and resulting raids might have led to establishment of 'larger, better organized residential groups as a form of defence' (1985: 338). Similarly, he argues that larger, stronger communities would be beneficial during the times of famine, when they would be able to raid neighbouring communities and/or extract tribute (1985: 339).

Besides warfare, another important role of kings in gaining legitimacy and power was performance of public rituals and ceremonies, and religion has been suggested as another factor affecting settlement locations. Ancient Maya settlements are often associated with bodies of water and caves, as these served as portals to the underworld, the place of ancestors and deities, such as *Chaaks*, and were often used for rituals and ceremonies (Redfield and Villa Rojas 1967; Rissolo 2003). These locations were important enough that in areas without natural caves, the Maya would sometimes create them artificially (Brady and Ashmore 1999).

When examining these factors, we see that different ones can create similar patterns, and that factors often interact to produce certain patterns. Understandably then, it is sometimes difficult to distinguish between the factors responsible for these changes. More worrying, however, and appearing still too often in studies dealing with similar subjects, is the focus on a single factor (e.g., droughts, deforestation, warfare), the assumption of correlation equals causation, and the formation of interpretations without testing other possibilities. Many studies dealing with human-environmental relationships have been, therefore, criticised for being environmentally deterministic and ignoring the importance of cultural and social factors, such as religion, ideology, political strategies, and economic organisation. To avoid this pitfall, the changes in settlement patterns (explored in Chapter 6) are here contextualised by the exploration of changes in agricultural and water management strategies (Chapter 7). Furthermore, settlement, subsistence and water management histories are then complemented by the exploration of the cultural and political trajectories of Maya society (Chapter 8).

3.2.3. Subsistence and water management strategies

Overview of approaches to subsistence strategies

As with the settlement patterns and population estimates discussed earlier, our understanding of Maya subsistence strategies has changed significantly over time. From the 19th until the mid-20th century, most researchers argued that ancient Maya subsistence was almost solely based on non-intensive slash-and-burn (swidden) agriculture (Turner 1978: 13), with the most prominent crop being maize, complemented by beans and squash. This was closely linked to the settlement models of the same period, where settlements were assumed to be oriented around vacant ceremonial centres, with widely dispersed rural settlements that accommodated the fallow periods required by slash-and-burn agriculture, occupied by peasants relying on swidden practices to produce enough food both for themselves and for the nobility living in the ceremonial centres (Linton 1940; Bullard 1964; Sanders 1979). This view of non-intensive swidden agriculture as the main means of subsistence was partly based on the evidence of increased fire frequency coincident with reduced tree pollen and increased pollen of domesticated plants, such as maize or manioc, which appeared in the Maya lowlands in the mid- to late Holocene (~2000 BC, Pohl et al. 1996; Pope et al. 2001; Neff et al. 2006; Kennett et al. 2010). It was thought that the evidence of fire indicated forest clearance as part of slash-and-burn farming (Kennett et al. 2010). This view seemed to be supported by settlement surveys and excavations conducted in the monumental cores of the sites that produced low population estimates, fitting well with the limited carrying capacity of non-intensive slash-and-burn agriculture (Cowgill 1960; Turner 1976: 74; Puleston 1978: 229). It was also supported by the fact that many modern Maya communities still practise this subsistence strategy today (Morley 1946: 141; Dahlin et al. 2005: 231).

As discussed previously, in the late 1960s, the 'vacant ceremonial centre' view began to be revised with a growing focus on settlement beyond the monumental epicentres. Settlement surveys conducted at sites, such as Barton Ramie in Belize, Tikal in Guatemala and Copan in Honduras, facilitated more robust estimates of overall population, including urban populations – populations that clearly could not be solely sustained by non-intensive swidden practices – and proposed more labour-intensive models of Maya agriculture (Harrison and Turner 1978; Sanders 1979; Adams 1980; Siemens 1982; Lohse 2004). Further intensive surveys, later assisted by remote sensing (e.g., satellite imagery and recently also LiDAR technology), uncovered widespread and dense agricultural terracing within and beyond the urban centres (e.g., Killion et al. 1989; Pyburn 1998; Dunning 1996; Chase et al. 2011). In addition, there was new evidence for raised fields and kitchen gardens around individual Maya houses. Besides maize, which did form a substantial part of the ancient Maya diet, the plant remains recovered from fields and kitchen gardens included fruit trees, such as cacao, avocado, papaya, nance, mamey, guava, and calabash, as well as garden vegetables and medicinal herbs. Many of these, sometimes even maize, were planted in the area close to the house; beehives and turkey stocks were also kept around the home (Kintz 1990: 12–14; Ball and Kelsay 1992; Fedick 1995; Anderson 1998: 291; Becker 2001: 440; Trigger 2003: 302; Lohse 2004: 129).

Dating intensive agricultural features is complicated, and even those that are more 'datable', such as terraces, may have been developed and expanded over time (Murtha 2002). For now, the earliest appearance of terraces has been generally placed in the Late Preclassic/Early Classic period (~AD 250, Beach et al. 2002; Wyatt 2005, 2008). They are much more common by the middle of the Classic period (AD 500–600) and then abandoned in the 9th century (Murtha 2002, although in some places, they may have continued to be in use until the Early Postclassic, e.g., Minanha, Macrae and Iannone 2011). In addition to these diverse, intensive agricultural practices, there were various water management strategies, including the creation of features such as *aguadas*, ditches, canals, aqueducts, dams and reservoirs. The earliest appearance of water management and conservation techniques also appears during the Late Preclassic period (Matheny 1978; Freidel and Scarborough 1982).

What were the drivers in the intensification of agricultural strategies?

There are several different lines of reasoning regarding the intensification and diversification of agricultural strategies. One approach is linked to population pressure and land shortage (Boserup 1965; Turner and Harrison 1983a, 1983b: 248, 266). Intensification is also seen as a response to the environmental consequences of a slash-and-burn agriculture, such as deforestation, soil erosion (Anselmetti et al. 2007; Beach et al. 2008), reduction in soil fertility and moisture, and amplification of drought in general (Shaw 2003; Dunning et al. 2012; Cook et al. 2012), and it has been also linked to climate change and aridification trends (Douglas et al. 2015b; Tainter 1988, 2000). It has also been argued that changes in agricultural and water management strategies have socio-political causes rather than ecological ones (Smith 2003; Normark 2008).

Population growth: One of the main proponents for the link between agricultural change and population growth was the Danish agroeconomist, Ester Boserup. Boserup (1965) argued that there is an obvious correlation between the two variables. Contra to Malthus's (1798) pessimistic view that population growth depends on agricultural production, which is finite, with population growth therefore being the dependent variable, Boserup (1965: 11) argued that the causal direction was in fact reversed, with population growth being the independent variable, that is, the one actively driving agricultural developments. Her reasoning was based on two specific assumptions: a 'law of least effort' and a 'law of diminishing returns'. The law of least effort states that in cases where people have a choice, they will usually not work more than necessary to get what they need or want. Therefore, farmers will only adopt more labour-intensive practices under pressure. The law of diminishing returns refers to a point beyond which the level of returned output decreases in relation to input; so within the system of agricultural intensification, yields decrease in relation to labour input (1965: 28–31).

Applied to the Maya civilisation, proponents of population pressure theories argue that with the growing and increasingly hierarchical population, there would have been more demand for food and labour. The large building and artistic projects taking place during the Preclassic period and especially during the Classic period would have placed pressure on farmers to produce enough surplus to feed the growing population, including the nobility and artisans. The production of enough surplus would be further complicated by the fact that long-term storage of grain in the neotropical environment is virtually impossible (Webster 1985; Kennett and Beach 2014). In response, more intensive agricultural systems were developed. Apart from terracing, kitchen gardens, and forest management, intensification also involved development of wetland agriculture. Seasonal floodplains and *bajo*s (karst depressions) were used for agricultural intensification, for example by enabling the planting of a second crop in the moist soils during the dry season, or by constructing raised fields in the inundated areas – this allowed the reclaimation of land and control of water flow, thus providing better conditions for intensive farming (Dunning et al. 2002; Luzzadder-Beach et al. 2012; Beach and Luzzadder-Beach 2013; Kennett and Beach 2014). In relation to *bajo* systems, Gunn and colleagues (2002) suggest that the *bajo* edges were extended during more arid conditions at some Preclassic sites located in areas without perennial water sources, such as Calakmul.

Boserup's theory has not gone without criticism, however. Her critics especially attack the assumed unilinear course

of agricultural intensification from fallow slash-and-burn to intensive agricultural systems. In addition, they argue that there are other factors to population pressure, such as social organisation, political economy, technological improvements and innovation, environmental factors, competition or access to market, that can also influence agricultural intensification (Erickson 2006; Stone and Downum 1999; Morrison 1994, 1996).

Conservation strategies and technological improvements: It has been argued that in addition to addressing the demands of a growing population, features such as dams and terracing may have been required because of increasing problems with deforestation and soil erosion, consequences of the extensive slash-and-burn farming. As such, the adoption of these new intensification strategies, besides producing more food, also enabled better environmental conservation (Turner 1974; Beach and Dunning 1995; Beach et al. 2002; Kennett and Beach 2014). As mentioned above, the earliest agricultural features already appeared during the Late Preclassic/Early Classic period (~AD 250, Beach et al. 2002; Wyatt 2005, 2008). The early use of these conservation strategies also seems to be supported by sedimentary records, which show that the rates of erosion were highest during the Late Preclassic period and actually decreased during the Classic period, although they remained still many times higher than during the pre-Maya period (Anselmetti et al. 2007). At the same time, while erosion is perceived as a destructive process, it also has benefits: fertile alluvial and colluvial sediments from the upslopes of the bajos were deposited on the lower footslopes, allowing for agriculture in those areas (Dunning et al. 2002; Beach et al. 2003).

Another line of reasoning links the adoption of intensive agricultural strategies to aridification trends (Douglas et al. 2015b; Tainter 1988, 2000). Based on the evidence from hydrogen and carbon isotope records from lake sediment cores, Douglas and colleagues have argued that during the drying trend at the end of the Terminal Preclassic and beginning of the Early Classic period (~AD 200–500), the resultant reduced rainfall would be insufficient to support slash-and-burn farming; as a response, intensive agricultural practices were adopted, especially in places with reliable water sources, including seasonal and perennial wetlands (Douglas et al. 2015b: 5611). Another drying trend during the Late/Terminal Classic period has been correlated with the extensive use of intensive agricultural techniques, especially wetland agriculture and complex water management, but also with changes in settlement patterns and the eventual abandonment of both intensive agriculture and of many Maya sites in general (e.g., Luzzadder-Beach et al. 2012; Beach et al. 2009; Shaw 2008). Based on climatological data, the later part of the Early Classic and Late Classic periods (~AD 400–700) were much wetter, but this was, however, followed by several periods of prolonged droughts (sometimes several years long), with peaks around AD 760, 810, 860 and 910 (with slight variations, depending on region and proxy; see Chapter 5; Haug et al. 2003; Hodell et al. 2001, 2005a; Webster et al. 2007, Kennett et al. 2012). It is also often argued that the favourable conditions during the wet period enabled a population explosion and aggregation, as well as the development of a more hierarchical society, creating conditions in which the high population was dependent on high yields made possible by intensive agricultural techniques and stable and sufficient rainfall (e.g., Gunn and Adams 1981; Folan et al. 1983b). According to this line of argument, it then follows that with decreased rainfall and periods of drought during the Terminal Classic, such a system would be difficult to sustain and eventually would collapse completely.

Socio-political complexity as a stimulus: Hypotheses based on environmental factors, such as deforestation or drying trends discussed above, are often seen as environmentally deterministic, downplaying the socio-political context. A more socio-political perspective, as argued for example by Normark (2008: 230), suggests that 'subsistence and water management is political before it is ecological … there are always decisions to use certain crops, where to live, how much labor should be invested, etc. To say that these decisions were the result of ecological factors misses the point that the ecological situation for a society always is the result of earlier socio-political decisions that have transformed environment'. The socio-political framework for development of agricultural intensification and water management is based on the argument that with a growing elite class and non-agricultural specialists, the need for labour and sustenance for all those specialists grew as well. That meant attracting political subjects who would be providing the sustenance, and it meant the use of intensive agricultural and water management strategies that would be capable of supporting the high population densities. For example, it has been argued that intensification of agriculture, such as the construction of extensive terracing systems or ditch field systems, was controlled politically from top down (Chase and Chase 1996: 808; Bevan et al. 2013; but see Wyatt 2008: 11), as well as the development of more active and more centralised control of water resources (large urban reservoirs) in the Classic Maya centres (Lucero 1999, 2002, 2003, 2006a, b; Scarborough 1998).

However, the main point of a theory that prioritises socio-political complexity as a stimulus is that the growth of rulership and an elite class in Classic Maya society eventually led to increasingly frequent and intense warfare between competing centres and ever-changing alliances (e.g., Demarest 2004b; O'Mansky and Dunning 2004; Demarest 2013). This led to further demand on production of food surplus because, as pointed out by Demarest: 'As in all warfare, there are high costs in terms of subsistence support and transport for the mobilisation of forces, weapons, fortifications, and reconstruction. Yet at the same time there is a loss of farmers and a disruption of the agriculture that maintains all of those activities' (2013: 26). According to proponents of this hypothesis, it was political and economic factors, such as rivalry between the centres or sometimes even within the centres

themselves, resulting in warfare and decisions made based on short-term thinking, which eventually led to crisis and 'ecological self-destruction' (Demarest 2013: 27). There is also a hypothesis, based on observed changes in weaponry, that warfare practices began to change from as early as the Early Classic, reflecting the influence of rules of engagement brought into the Maya area by groups that were heavily influenced by central Mexican culture. These groups and their rules of engagement, which sanctioned more widespread killing than was the case in Classic warfare, eventually triumphed, causing the downfall of Classic cities, rulers, and much of Classic-period cultural values (Aoyama and Graham 2015; Graham in press).

Implications of environmental variation, especially on water management strategies

In addition to the above-mentioned hypotheses, there is considerable environmental variation in different Maya regions, resulting in diverse subsistence strategies, different responses to changing rainfall patterns, and therefore different agricultural and water management strategies as well as settlement patterns (e.g., Demarest 1996; Dunning et al. 1998; Fedick 1996). For example, Dunning and colleagues (1998) differentiate 27 zones across the Maya lowlands based on climate, geology and drainage. The impact of, for example, high seasonal variability in precipitation across the Yucatan Peninsula would differ significantly depending on the area. The majority of northern lowlands (with the NE corner around Yalahau region being an exception), with average annual rainfall often seen as barely sufficient for maize production, or places where agriculture is dependent on canal irrigation and other similar strategies, reduced rainfall or a shift in the onset of the rainy season could have a significant effect (Yaeger and Hodell 2008). Furthermore, different geological conditions affect soils and their fertility, drainage, and erosion (Fedick 1995), as well as access to surface/potable water in the region. Northern Yucatan, as discussed above, has almost no surface water, but water is accessible through sinkholes and wells (Weidie 1985; Houck 2006). In contrast, the southern lowlands have rivers and lakes, however in many places, where surface water is lacking, the water table is too deep or unpredictable to dig wells (Folan et al. 1983a; Siemens 1978; Harrison 1993: 78). Consequently, water-management solutions are very variable across the Maya area and can differ even within a few kilometres. Water management research has gone through a similar development process to Maya archaeology and settlement and subsistence studies. At first, researchers focused on monumental centres and only later, thanks to settlement archaeology, were rural settlements and water management in common households explored (Johnston 2004: 288).

At several Maya centres, the largest architectural complexes were constructed at the high points of the karstic terrain, and large reservoirs intended to capture the water flowing from the elevated terrain were built next to these complexes (Scarborough 1998: 139). Sites such as Tikal, Copan, Nakum, and Uxul show sophisticated and complex water management systems, often using paved canals and aqueducts incorporated into the monumental architecture to collect and distribute water into reservoirs (Scarborough and Gallopin 1991; Scarborough 1998; Koszkul and Zrałka 2013; Zrałka and Koszkul 2015; Seefeld 2013). Research at these sites shows that the Classic Maya centres prioritised active centralised control of their water resources in comparison to the more 'passive' Preclassic systems (Scarborough 1983, 1993, 1996, 1998). However, although large urban reservoirs certainly exist at some sites (and might be over-represented in the record because of their visibility), these are not the only water systems that were used. For example, use of rural wells played important roles in several regions of the Maya lowlands (Johnston 2004), and features such as *cenotes, rejolladas, dzadzes*, wells, and *chultuns* are crucial in the northern lowlands, given the lack of surface water sources, such as rivers and streams. Therefore, it is misleading to examine only a few types of water management strategy to understand the whole Maya region (Harrison 1993; Johnston 2004); neither is it very useful to focus on just one or two agricultural strategies in isolation.

Implications of changes in agricultural and water management strategies

Inherent variability in subsistence and water management strategies has important implications for various aspects of Maya culture, indicating that while it is important to understand the drivers behind intensification and diversification of agricultural and water management strategies, it is equally important to identify and understand how, in turn, the resulting changes relate to and affect aspects such as settlement sizes and distribution, economy and trade networks that connect different ecological micro-regions and socio-political organisation.

From the outset, the adoption of agriculture enabled population growth, development of larger settlements and eventually low density or agrarian-based urbanism (Graham and Isendahl 2018; Kennett and Beach 2014; Zeder 1991). Increased population pressure and intensification of agricultural systems might have led to the use of marginal zones initially not suitable for agriculture, such as wetlands or lakes (Kennett and Beach 2014; Dunning et al. 2002, 2006; Beach et al. 2009), but at the same time also to shifting and/or expansion of settlements to previously unoccupied areas. For example, at Copan, between AD 700 and 850, when it reached a peak in socio-political complexity and population, the rural settlement expanded into the foothills, which were previously uninhabited (Freter 2004: 101). Similarly, changes in water management strategies are likely also to have an effect on settlement patterns (and vice versa). Given the importance of water for agriculture, but also for everyday use (bathing, drinking, cooking, washing), water accessibility was certainly one of the most important factors in settlement location choice (Gunn and Folan 2000). The large majority of early settlements were located in proximity to water sources. However, by the Classic period, the Southern

lowlands witnessed settlement in previously unoccupied areas without permanent water sources, taking advantage of more distant fertile soils (e.g., Scarborough 1993). Such a step, in turn, inevitably involved changes in how water was managed and, especially, stored. Furthermore, settlement pattern changes might relate to possible shifts away from mainly agricultural economies to more diverse subsistence strategies in an attempt to reduce the impact of agricultural failure. Postclassic clustering of inland settlements around lakes and rivers might be linked to attempts to consolidate a more balanced subsistence base. Similarly, population movement and growth of coastal communities indicates increased reliance on maritime resources, but also growing and changing trade networks and salt production (Andrews 1993; Golitko et al. 2012; Golitko and Feinman 2015; McKillop 2002, 2005).

What impact would agricultural and water management changes have had on Maya socio-political organisation (and vice versa)? As discussed above, the Classic Maya concept of Maya kingship was heavily based on navigating the interface between politics, economy, ritual and warfare (Marcus 1993; McAnany 1993; Webster 2002; Demarest 2004a). Some of the implications of politics and warfare have already been discussed, but another important role of the kings was performance of public rituals and ceremonies. These were based on the Maya calendar, astronomical observations and the agricultural cycle and had two functions. They served to bring people together, and in this way elites obtained access to food and labour (Demarest 1996; Freidel 1981). At the same time, through rituals and ceremonies, kings were appeasing gods and ensuring the proper order of the universe, including the timely change of the seasons (Demarest 2004a; Kennett and Beach 2014). Furthermore, rituals, such as the veneration of ancestors and calendrical period endings, played an important role in legitimising kings (e.g., Rice 2007); while those related to the agricultural cycle (e.g., planting, harvesting or rainmaking rituals) might have had functioned as a reminder of a reciprocal bond between the king and the farmer (Crawfurd 1830).

Similarly, the development of large urban reservoirs controlled by kings and the centralised control of water resources in Classic Maya centres in general played an important role in the claim that control over water gave kings authority over their subordinates and helped to centralise and consolidate their political power (Lucero 1999, 2002, 2003, 2006a, b; Scarborough 1998). This however, as Lucero and Scarborough suggest, might have led to the demise of these kings as well (Lucero 2002, 2003, 2006b; Scarborough 1998). In the case of diminished rainfall, such a centralised reservoir-led system would prove highly inflexible, possibly further exacerbated by lack of food if harvest failed, as well as increased disease. People might have blamed kings who claimed to have a relationship with supernatural deities associated with crops, rain and fertility; this ultimately might have led to the loss of trust in kings and erosion of their political power and authority (Lucero 2006b: 187).

3.2.4. Exploration of ritual activity in written records

Possible evidence of responses to environmental or climatic stress in Maya hieroglyphic texts is explored in Chapter 8. The evidence is based primarily on the study of, what is argued are, agricultural/rainmaking rituals appearing in Classic Maya inscriptions and their possible change through time in response to climatic stress.

Ritual activity as a mechanism of dealing with environmental stress has been discussed in many ethnographic studies worldwide (e.g., Frazer 1911; Butree 1930), but also specifically in the Maya area. Nash discussed cave rituals performed in Chiapas during the times of drought, in order to ask for rain (1970: 45). Similar rituals have been reported also among the Tzotzil of Zinacantan (Gossen 1999: 185), Nahua and Otomi people in Veracruz (Sandstrom 2005), and the use of ritual as a coping strategy to anticipate and mediate risk among the lowland Maya has been also discussed by Freidel and Shaw (2000). Our own ethnographic study among contemporary Maya communities in Belize, discussed in Chapter 4, showed that variety of contemporary religious ceremonies related to extreme weather events and drought in particular have survived in some areas until today. It is very likely that at least some of these rituals or certain aspects of them might have survived since Precolumbian times. Several anthropologists and archaeologists, focusing on contemporary Maya rituals, have commented on how much of the Precolumbian beliefs can still be detected (e.g., Thompson 1930; Vogt 1976, 1998; Schuster 1997). For example, ethnologist Evon Voght said that ‘considering that 500 years have elapsed since the Spanish Conquest, I am impressed with the enduring nature of Classic Maya concepts and beliefs’ (cited in Schuster 1997: 50). Similarly, Schuster pointed out that the ‘rites I have witnessed in 1996 were rooted deep in antiquity’ (1997: 50). Furthermore, ritual theorist Pierre Smith (1982) made a distinction between ‘periodic’ and ‘occasional’ rites. While periodic rituals are performed cyclically, occasional rituals are performed when needed, therefore increasing ritual frequency. For example, increased frequency of ritual activity in times of environmental stress among the Maya has been documented in several ethnographic studies (e.g., Girard 1949, 1995; Freidel and Shaw 2000). More important for this particular study, Holy Moyes (2006), based on her work on caves in Western Belize, showed that there is an evidence of increased ritual activity in caves during the latter part of the Late Classic period (ca AD 680–960), coincident with climatic drying. Moyes and her colleagues therefore argue that this change was a manifestation of a Late Classic drought cult, in direct response to drought conditions (Moyes et al. 2009). This emphasis on ritual activity at the end of the Classic period, in addition to the data discussed above of climatic drying in the Terminal Classic, led Christophe Helmke, Andrew Bevan and I to examine Late and Terminal Classic texts for indications of ritual or ritual changes that might be related to responses to drought. We formed a hypothesis that two particular kinds of rituals appearing in Terminal

Classic texts might be proto-forms or precursors of the present-day rain-making ceremonies. This hypothesis led us to examine the Maya hieroglyphic corpus looking for these two types of rituals and then comparing them with local palaeoclimatic records.

This specific case study is conducted in the wider context of cultural and political history based on the Maya hieroglyphic texts, and complemented by examination of other changes taking place in the hieroglyphic record and iconography through time, but I focus specifically on the transition between the Classic and Postclassic period – the Terminal Classic. The Terminal Classic period is defined by considerable changes taking place in the Maya area and we would expect that at least some of these changes might be reflected in the hieroglyphic texts, possibly providing another perspective of the processes behind these changes. For example, changes in the composition of scenes on stelae, from featuring the single ruler to multi-figural 'conversation' scenes, have been seen as an indication of a change in political ideology or political organisation (Schele and Friedel 1990; Krochock 1991; Grube 1994; Zrałka 2008). Similarly, the dedication of carved monuments by rulers of secondary centres, using emblem glyphs of former primary centres and claiming the title of divine kingship, has been interpreted as claims to independence and again seen as a power-sharing mechanism (Schele and Freidel 1990; Rice 2007). The appearance of foreign features in architecture, iconography and writing, on the other hand, has been linked to foreign influences resulting either from migration or invasion of people from different regions to the Maya area, or from interaction (mostly through trade) between Maya and other regions (e.g., Andrews 1990; Carmack 1981; Grube and Krochock 2007; Justeson et al. 1985; Kepecs 1999; Rice 2004; Vargas 2001; Pallan 2012; Wyllie 2002). These aspects are explored in Chapter 8.

4

Human Responses to Environmental Stress: Ethnographic and Ethnohistoric Insight

Co-authored with Sean Downey

4.1. Introduction

In recent decades, much research in Maya studies has focused on climate change. However, as discussed in the last chapter, it is weather and other short-term environmental changes, rather than climate change *per se*, that people experience, talk about, and respond to (Pilatt 2012: 40). Therefore, before exploring long-term climatological, archaeological and epigraphic data in following chapters, here we will examine the human-environment relationship at the human decision-making scale, focusing particularly on human responses to spatial and temporal variations in weather and environmental stress. How are these variations perceived, experienced, interpreted and responded to by individuals on a day-to-day basis? And how are these variations remembered on a longer-term scale, leading to the development of adaptation strategies?

To answer these questions, observations from ethnographic fieldwork conducted among present-day Maya communities in Belize will be used. We interviewed community members about historical climate variability, drought, and adaptation to changing weather patterns and our preliminary results were published in Downey and Jobbová (2011). Here, we extend our analysis, expanding on the observations gathered from fieldwork and extracting further details from audio recordings and interview notes in order to address these questions as well as the general aims of this book.

This chapter will also explore the difference between *perceived* and *measured* weather and climate (Goebbert et al. 2012; Wanyun Shao 2015). To do so, a new, unpublished analysis of local rainfall patterns is presented along with records of historical droughts from archival sources; these are then compared with the weather observations that were reported during the interviews with the Maya communities in Belize[3].

4.2. Weather, climate and drought

At this point, it is worth establishing working definitions of terms that were both used during the interviews and employed throughout this book: What is meant by the terms weather, climate, environment and drought?

Climate is defined as the long-term average of the atmospheric elements that constitute *weather* or, more rigorously, as a statistical description of the mean and variability of elements, such as temperature, precipitation, and wind speed and direction, that are made over a period of time ranging from months to thousands or millions of years (IPCC 2007). The standard period for averaging these variables is 30 years, as defined by the World Meteorological Organisation, although different averaging periods, sometimes much longer than 30 years, are used in climatological studies. In general, we framed our interview questions in terms of generational-scale climate variability. For example, when we asked older people how the climate had changed since they were young, in some cases this could represent period of 50 to 70 years. For shorter periods of time (such as the immediate past), we asked about 'weather patterns', rather than climate. However, this differentiation is presented here for clarity; in the interviews, the meanings of 'weather' and 'climate' were inferred by our interviewees from the context of the question rather than by any formal prompts or definitions.

More generally, we might also define *environment* as the surroundings or conditions in which people, animals and plants live and interact. Referred to as an *ecosystem* by the IPCC (2019), it is defined as 'a functional unit consisting of living organisms, their non-living environment and the interactions within and between them'. Environment is often taken to mean those surroundings affected by human activity, but in this research, it is also used to describe natural conditions (i.e., those not modified, or not clearly modified, by human activity).

Drought is an environmental phenomenon that is particularly difficult to define, because what constitutes drought is relative and highly dependent on prevailing local climate and moisture requirements. For example, while in the UK 'an absolute drought is defined as a period of at least 15 consecutive days on none of which is there more than 0.2mm of rainfall', in Libya drought is recognised only after two years without rain (National Drought Mitigation Center, 2021). Therefore, no specific duration or amount of rainfall is universally applicable. Dictionaries tend to define droughts along the lines of 'a prolonged period of abnormally low rainfall, leading to a shortage of water' (*Oxford Dictionary*), which 'causes extensive damage to crops or prevents their successful growth' (*Merriam-Webster*). The National Drought Mitigation Center (2021) defines drought as 'a deficiency

[3] Approval for human subject research was received from the University of Arizona Human Protection Program (no. 09-0418-02) and the Belize Institute for Social and Cultural Research (Permit No. ISCR/H/2/5).

of precipitation over an extended period of time – usually a season or more – resulting in a water shortage for some activity, group, or environmental sector. Its impacts result from the interplay between the natural event (less precipitation than expected) and the demand people place on water supply'. This definition acknowledges that droughts result from both environmental and social factors, and it is this definition that we will use here, although with the caveat that the term 'drought' is a rather clumsy word considering the complexity of stresses that occur in humid tropics. For many, the humid tropics are emblematic of an abundance of water. Yet, variable rainfall patterns – too little or too much rainfall during a rainy season; sufficient rainfall but at the wrong time of year; or a series of long dry seasons – are critical issues for many people living in the humid tropics because of water storage limitations and distribution systems, as well as reliance on rainfall for agriculture. Because of the many combinations of environmental stress that can occur, the term 'drought' is only applicable to a portion of these, i.e., periods of low rainfall that are long enough to affect crop production and water availability. For these periods of low rainfall, when possible, we make a distinction between agricultural drought (mostly affecting vegetation, e.g., when evaporation levels exceed precipitation) and hydrological drought (affecting groundwater levels, e.g., after long periods without precipitation).

4.3. Geographic, climatic and ethnic background of the case study areas

In 2011, we conducted ethnographic fieldwork in four villages in the Cayo District and in two Toledo District villages in Belize (Fig. 4.1), most of these with an indigenous Maya population. We interviewed people about historical climate variability, events such as droughts, floods, hurricanes, fires and locusts, how such events affect(ed) people's lives and what coping strategies they develop(ed) in response to these events on day-to-day basis and on a longer-term scale to adjust to changing weather patterns. The two regions were chosen partly because of our previous research interests but also because these areas are significantly different to each other in geology, climate (the south is much wetter than the north), land tenure systems, settlement history and economic opportunities, and could, therefore, make for a good comparative study within Belize.

The Cayo District borders Guatemala in the west of the country and geographically, it is the largest district in

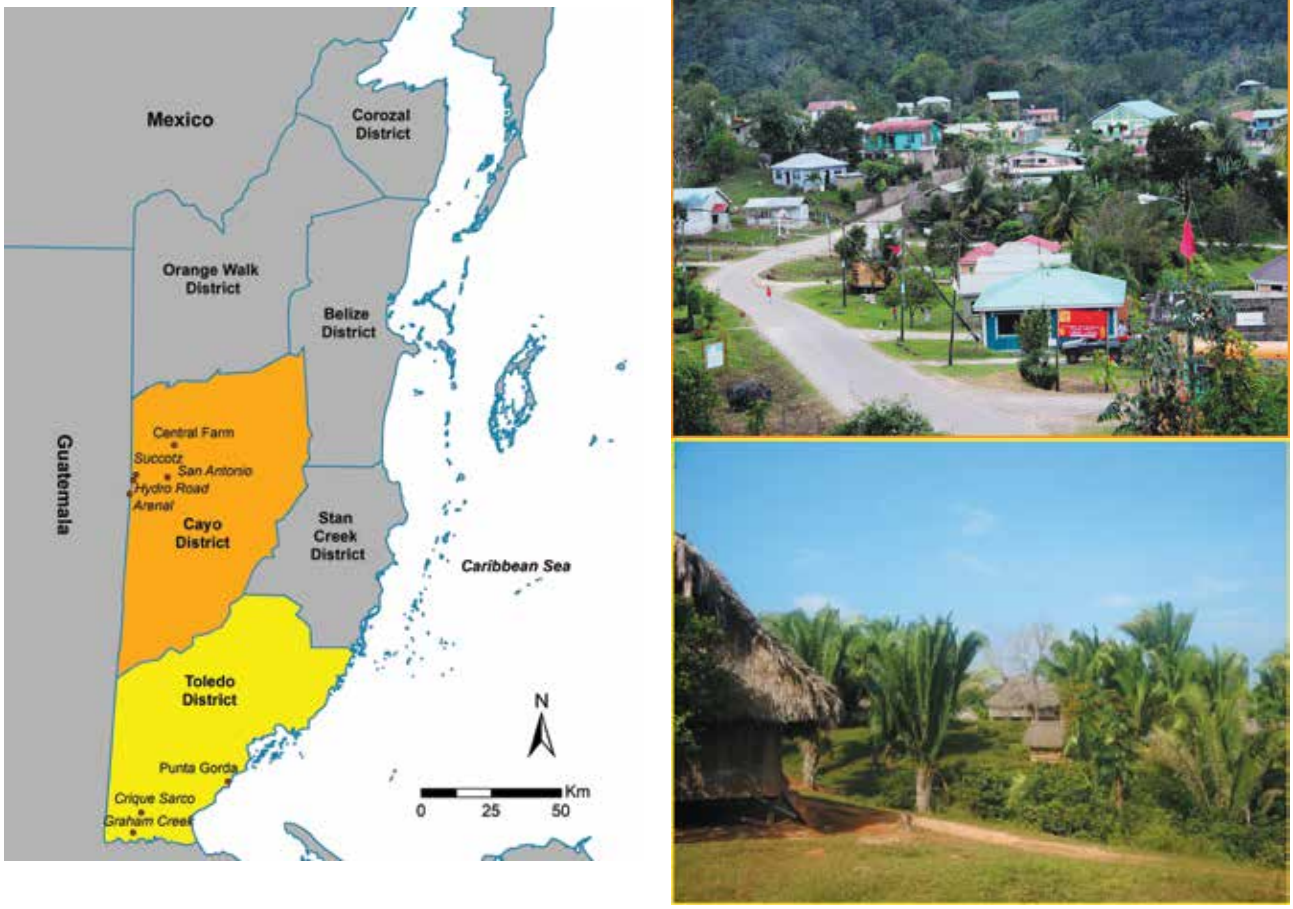


Figure 4.1. a) Map highlighting Cayo and Toledo districts, b) San Antonio village in the Cayo District (top), Crique Sarco village in the Toledo District (bottom). (San Antonio photo: by San Antonio Village-TANAH, © Casado Internet Group, Belize).

Belize. It is a quickly developing and, in the local context, a more urbanised region, with booming tourism and many economic opportunities in general. According to the 2010 Population and Housing Census (none has been held since then), it had 75,046 residents (p. 8, Table 2). The Cayo District includes the country's capital, Belmopan, as well as the town of San Ignacio and its immediate neighbour, Santa Elena; the two together form the second largest urban area in Belize, surpassed only by Belize City. There are also many villages in the district, including San Antonio, San Jose Succotz and Arenal where we conducted the interviews. The district also contains pre-Columbian Maya sites, such as Caracol, Xunantunich and Cahal Pech, which draw a large number of tourists.

Cayo's climate can be cooler and drier in comparison to other regions, especially the south, with an average precipitation of 65–80 inches (1651–2032 mm) a year (National Meteorological Service of Belize). The district's economy, which was once mainly based on logging and chicle (a natural source of gum that is tapped from the *Manilkara* tree), today relies on agriculture (predominantly citrus and bananas), cattle ranching and tourism (based on the 2010 census, 31.5% of households were reported to be involved in agriculture; Population and Housing Census (2010), Table HC5.2). In addition to the ancient Maya sites, the district's two rivers, waterfalls, many caves and several nature reserves also draw international visitors.

The Maya communities in the Cayo District that we interviewed consist of Mopan and Yucatec Maya. Many of them migrated to Belize either from neighbouring Guatemala or from Yucatan, mainly in the mid-1800s, during the Caste War between the Maya and Mestizos. Over subsequent decades, intermarriage with other Belize ethnic groups (Spanish [Mestizos], Creoles, Garifuna) occurred, but there is a significant cultural continuity evident in their traditions, such as music, dances and fiestas, and in their rituals and community institutions (Wilk and Chapin 1990: 15).

In comparison, the Toledo District, located in the southernmost part of Belize, is the most sparsely populated and least developed region in the country. According to the 2010 census, it has a population of 30,785 people, with more than half being Maya (66.5%, in comparison to 8% in the Cayo District; Population and Housing Census (2010), Tables 2 and 8). While known as one of the more multicultural districts, 66% of the population is made up of Mopan and Q'eqchi' Maya living in 38 different villages (Census 2010, Table 8). In the Cayo District, many Mopan Maya migrated from the Peten, whereas the majority of the Q'eqchi' population in the Toledo District migrated from the Alta Verapaz region of Guatemala and from Honduras, escaping forced labour and military draft (Wilk 1997). Q'eqchi' Maya are linguistically and culturally distinct from the Mopan. In comparison to the Mopan, their villages, especially in the south, are usually much smaller and isolated, and neglected by the government of Belize, with less access to services such as healthcare or education. Despite boasting archaeological sites, rainforests, networks of caves, waterfalls and offshore barrier reefs, Toledo is less visited by tourists and it is considered 'off the beaten track', compared to the Cayo District.

Toledo District has a much higher precipitation level than any of the other Belize districts. For comparison, the annual precipitation in Belize's northernmost town Corozal is 60 inches (1,524 mm), while Toledo's precipitation can be as much as 160 inches (4,064 mm) a year (National Meteorological Service of Belize). This makes it very suitable for the agriculture that Toledo's economy heavily relies on: mainly corn, beans, rice, and more recently, cacao. Coffee, sweet potato, yams, chili, hot peppers, avocado, oranges and plantain are also grown and sold at the market in Punta Gorda (the district capital, administrative centre and only town of significant size). Based on the 2010 census, 62% of households in the district work in agriculture (Population and Housing Census (2010), Table HC 5.2). Since a large portion of the district borders the sea, another important economic activity is fishing.

4.4. Interviews

We conducted 64 semi-structured interviews. These were carried out in four villages in Cayo (San Antonio [25], San José Succotz [15], Arenal [5] and along the Hydro Road toward the North Vaca Plateau [5]) and two villages in the Toledo District (Crique Sarco [10] and Graham Creek (4). We interviewed mainly older people still involved in agriculture. We began the interview with basic demographic questions, such as how old they were and where they grew up, and we asked them to describe their lives when they were children. We then continued with farming-related questions, such as: Where did your family grow crops? On Crown's land[4] or private land? Was the land productive? To see if they remembered any potentially more extreme environmental/weather events, we asked: 'Do you remember any time in the past when your crops failed because of drought, a hurricane or any other reason? This was combined with questions about specific information, such as dates, how long these events lasted and what the respondents did in response. To determine if they perceived any long-term change in weather patterns (i.e., climate change), there were questions about their perception of change: 'Do you think the weather has changed since you were young?' If the answer was yes, this was followed up with: 'How and when did the change take place?' Finally, we also asked if any specific ceremonies were performed to mediate the effects of any of the droughts they might have mentioned[5].

[4] In 1817, the British Government declared all the land in Belize, not acquired before this date as "Crown Land" or a property of the Crown. In 1872, the Crown Lands Act established reservations for the Maya (and Garifuna) and the British prevented them from owning the land. They were only allowed to occupy certain lands defined by the crown and were treated as a source of labour (Bolland, 1977; Iyo et al., 2003).

[5] We only asked about ceremonies after the general questions about how they would respond to droughts and if there was anything they felt they could do to mediate the effects of drought. The direct questions about ceremonies were only included at the end of the interview if people

In addition, based on the research suggesting that birth-spacing may have been used in pre-industrial societies to control fertility (van Bavel 2003, 2004; van Ginneken and Jeroen 1974), we also asked a series of gender-specific questions about female reproduction, birth-spacing and environmental stress (however, this part of the research is not discussed here).

Sean Downey, conducted previous ethnographic fieldwork in the Toledo District (2009, 2010). He focused on the historical ecology of Q'eqchi' Maya swidden agriculture practices between 2005 and 2008. Eva Jobbová participated in archaeological fieldwork in the Cayo District, between 2005 and 2008. Based on our respective experiences, we began the ethnographic fieldwork with certain expectations. Given the different environmental conditions and different levels of development between the two districts, we expected to find that villages in the Cayo District were still practising traditional forms of swidden agriculture, but less extensively than in Toledo. We also expected to find that farming was heavily supplemented by other economic activities, such as trade and commerce – this transition to a more diversified economy occurred earlier in Cayo than in Toledo. Finally, we also expected to encounter different traditional belief systems in both areas based on previous reports (e.g., Thompson 1930; Girard 1949, 1995; Vogt 1976, 1998; Schuster 1997), especially those related to subsistence practices. In addition, because different Maya ethnic and linguistic groups live in each region, we expected specific customs and ceremonies to also differ.

In the following sections, we summarize the results from our ethnographic interviews. Table 4.2 (p. 41) provides a concise summary of the main topics we investigated and how people in each of the study locations responded.

4.4.1. Cayo District – San Antonio

The village of San Antonio is located southeast of San Ignacio in the foothills of the Mountain Pine Ridge and Maya Mountains. It was founded around 1876 by small Yucatecan refugee groups, and it is the largest Maya settlement in Belize, with the majority of its inhabitants being Mopan Maya (Wilk and Chapin 1990). The history of its foundation is unusually well understood for a small Belizean village due to the efforts of Alfonso Tzul, a village resident who recorded the local history in his book, *After 100 years: The oral history and traditions of San Antonio, Cayo District, Belize* (Tzul 1993). According to Tzul (1993), the original settlers – small groups of men and their families who fled to Belize from Yucatan in the wake of the Caste War – were encouraged to leave the war zone and to re-establish themselves by farming in remote areas of Mesoamerica. The settlement was originally called *Osh Multun Kakab,* which in local Yucatec Maya means 'Three Mound Virgin Forest', but it was later renamed San Antonio after St. Anthony of Padua, whose statue was brought to the village by a Spanish Catholic priest. The settlers probably chose the place because of its rich soils and the presence of a perennial water supply. Even today, San Antonio is an agricultural community. Its inhabitants grow a variety of crops such as corn, squash, beans and peanut. Unlike their ancestors, who relied on swidden agriculture throughout the 20th century, the farming now is mostly intensive, mechanised, and oriented for the market in San Ignacio town. In addition, farming is increasingly being supplemented by trade and commerce and household income is supplemented through collecting and selling *cohune* nuts, logging, raising cattle and pigs and collecting *chicle*, as well as by seasonal labour. There are also three women's cooperatives, one of them is a bakery and the others specialise in making and selling pottery, jewellery, clothing, embroidery and hammocks. The perennial water supply or spring is known locally as *sayab*. There is archaeological evidence of pre-Colonial use of the spring and it is still being used today. People remembered the years when it dried up and therefore, it provides an important symbol of hydrological drought in the village's collective memory, making San Antonio an ideal location for an ethnographic/ethnohistorical study into the effects of environmental stress on rural populations.

Our interviews showed that people in San Antonio strongly agreed that there had been historical incidents of drought in the village. The earliest reliable incident was from around 1910, which reportedly led to some families leaving the village (Tzul 1993: 26). The most widely-remembered drought, however, was in 1949. Across Belize, the rainy season usually begins in April or May, but we interviewed six people who independently reported 1949 as a year when the rain did not begin until September or October. It was also documented in the village history (Tzul 1993). It was impossible to farm as crops could not grow. The farmers who experienced the drought said that even if they planted, the crops, especially corn, did not grow or remained small. They also said that many cattle died in San Antonio and around the country. The village well and the *sayab* both dried up and interviewees reported waiting until the middle of the night to fill buckets of drinking water or getting up at five in the morning to get water, which had collected during the night. There were attempts to deepen the well, eventually to 14 meters, but even this depth was not enough. As one of the interviewees pointed out, there were too many people and not enough water. Buses were sent by the government to take people to Privación to procure water, but according to one interviewee, the old people did not want to go because of a story about the place. *Privación* means deprivation or hardship in Spanish but, according to one interviewee, it also means to faint. According to the story, Privación was named after a strange illness that struck some children there and eventually killed them. The children started to tremble and then fainted, eventually regained consciousness, only to die shortly after. After children died, people were scared and abandoned the village, which then came to be known as Privación.

did not mention them on their own; many people would not speak about ceremonies without direct questions and sometimes, even then, reluctantly, due to conversions to Protestantism.

Another drought, which, according to several people, lasted from March until September, was in 1973. During that year, the corn did not grow. One of the farmers said that they replanted three times, but it was pointless and that it was a mistake to try to replant again and again. According to another interviewee, it was the worst drought she remembered (she was too young to remember the 1949 drought) because both wells in the village dried up. She remembered that there was only a little bit of water in the wells and people would have to wait hours to get one bucket of water; sometimes they would wait until 1 o'clock in the morning to get drinking water. So, they would go 6 miles to a place called *Sayaa*' (spring or *manantial* in Spanish) to get water. The interviewee's father had a horse and carried four buckets, and children would also carry small buckets. They would make the trip twice a day to get enough water for drinking and cooking. For washing, they would collect water every three days.

Other droughts were mentioned in 1935, 1961, 1965, 1995, 2010 and 2011, although none of these seems to be as widely remembered or to be as severe as the two instances mentioned above. In some cases, we received only relative dates, as several people said that they remembered that there was a drought when they were about 10 years old. However, it is likely that the age '10' in some cases might be a generic number (in a sense of 'somewhere around age of 10'), rather than expression of an exact date, so it is difficult to place some of these descriptions chronologically. Many of these mentioned droughts fell very close to one of the above-mentioned years, however.

Many people also expressed that they 'are currently [May-June 2011] in a drought' and several people still practising agriculture said that it had been really dry for that time of the year and, although many of them had planted at least once already, nothing was growing well and they were waiting for the rains to come to plant again. For example, one of the interviewees said that he had already planted on 22nd April and then for the second time on 18th May. Now he was waiting until it rained and then he would plant one more time. Another two farmers expressed a similar predicament and added that the previous year, 2010, was similar. One of the interviewees reported that in 2010, he did not harvest anything because it was too dry and nothing grew and he was afraid that it would be the same in 2011, or even worse. The same farmer also remarked that in 2010, it started to rain on the 22nd of May; when we interviewed him, it was 25th May and it had not rained yet.

Overall, our evidence strongly suggests that there appears to be a coherent collective memory of water shortage crises in San Antonio throughout the 20th Century, implying that water shortages have been an important and enduring feature of life in San Antonio.

In addition to agricultural and hydrological droughts, there were several other events reported, which, according to the interviewees, had similar effects to those of drought. Probably closest in effect were the swarms of *chapulines* (locusts/grasshoppers)[6]. People most often described the huge swarms of *chapulines* that descended on the village eating nearly every leafy plant they could find, including corn and avocado, and even *cohune* and *huano* leaves (used as thatch on the roofs) if they were still green: 'only stalks of the corn and bare stems of other plants were left'. After such an event was mentioned in one of the preliminary interviews, we consistently asked people if they remembered the swarms and how they affected the life in the village. The most often mentioned years were 1938, 1940 (2), 1941 (4), 1944 (3) and 1971 (according to one interviewee, 1941 would have coincided with drought, although 1941 was not mentioned specifically as year of drought).

Other extreme weather events, in this case natural disasters, described by people in San Antonio were a hurricane that struck Belize on the 10th of September 1931 (a category 4 hurricane and natural disaster, which was the deadliest in British Honduras history, killing an estimated 2500 people: [Rappaport and Fernandez-Partagas 1997]) and Hurricane Hattie in October 1961 (category 5 hurricane, which caused much greater damage but fewer deaths due to more warning: [Dunn 1962]). Only one person talked about the 1931 hurricane, unsurprisingly, as the majority of people would have been too young to remember. Everyone seemed to remember Hurricane Hattie, however. People talked about it in very specific terms, including the hour when it hit their houses and how much damage it caused both to houses and *milpas* (planting fields). Although many of the interviewees said that they were lucky because, at that time, the corn was already harvested and therefore they did not suffer from lack of food, there were others who said that everything was destroyed, they did not harvest anything and did not have food. In the cases in which people said that everything was destroyed, it is possible that they were referring to destroyed *milpas,* and the reference to the lack of food might have meant that other crops that they had planted in *milpas* and not harvested at that point were destroyed.

These responses illustrated to us that the memories of each type of natural disaster were recounted in a similar fashion and the coping strategies were largely the same. Perhaps the reason for the difficulty distinguishing between different types of events is that the livelihood effects of drought, locust swarms and hurricanes were similar and, therefore, they were conflated into the same semantic category in the collective memory.

So, what effect would the insufficient rain or other climatic events had on the people's lives and what did the villagers do? Although there were two interviews where people said that even if there was drought, they still had enough corn

[6] *Chapulines* are grasshoppers of the genus *Sphenarium,* however, these do not swarm. The locust that swarms in central America is a large locust *Schistocerca piceifrons.* which comes from the Acrididae family of grasshoppers, also called Central American Locust. Local people do not differentiate between them and the term *chapulines* refers to grasshoppers in general.

saved from the previous year, in many cases, the lack of harvest resulted in subsistence problems and, in the most severe cases, in hunger (this mostly applies to severe droughts in the past, e.g., 1949).

To cope with the situation, in the majority of cases, people used all the ecological knowledge and economic resources available to sustain themselves. In many cases, interviewees reported that they tried to replant once the rains finally came, although sometimes it was too late in the season. The latest period that farmers can plant corn is the end of June (spring crop). If the corn stalks do not have enough time to grow strong, they will be broken and flattened to the ground by the heavy rains. However, if the spring crop does fail completely, it is possible to plant a second crop, usually in November. This crop is called *Yaxkin* (or sometimes *Matahambre* – from the Spanish *mata–hambre,* 'kills hunger') and it is a different variety of corn that grows quickly and can be harvested in December or January. One of the farmers we interviewed said that: 'People began to do this second planting after one of the very long droughts 60 years ago, and then it became a tradition and people started to do it every year, and now they are even planting three times a year [April, June, October]'. The drought he referred to may have been the very long drought, mentioned by many, that occurred in 1949/1950 in San Antonio and Succotz). No one reported hand-watering corn-fields, most likely because San Antonio relied on wells and a spring rather than a river. Therefore, it would not only be impractical but also impossible because, according to interviewees, if there was no rain, there would not be enough water in the wells.

Other strategies used to cope with drought include increased hunting and gathering, expanded diet breadth and wage labour activities. The majority of people we interviewed said that during these dry periods resulting in poor or no harvest, they would rely on the forest for their subsistence. Men went hunting for peccary, armadillo, *tepezcuintle* (gibnut/paca), deer, birds and other game (Table 4.1 and Fig. 4.3 **p. 39–40**). One of the interviewees said that, in the past, people would not sell the hunted meat, but rather they shared the meat with other families and when the others went hunting, they returned the favour. However, this seems to have changed recently because game meat can be sold for profit in the San Antonio market.

The people of San Antonio also collected various forest fruits, such as *huano* palm fruit, palmetto, pacaya palm, zapote, mamey, yuca, coconut, cohune nuts and ramon fruit (see Table 4.1 and Fig. 4.2 **p. 39–40**). People also said that some of the root crops still grew because root crops do not need as much moisture and usually do not dry up. They also store well. Interviewees stated they would rely on macal, *camote* (sweet potatoes), cassava (yuca), cocoyam (taro) and yams. In fact, one of the strategies that people, especially women, often mentioned was adding macal, plantain or yuca to corn (if they had any) in order to bulk up the *masa* used to make tortillas (macal was boiled, grated, put in the sun to dry and then mixed with the corn). Sometimes, the women would use these root crops as substitutes for corn, if there was no corn left. Most of the women we interviewed went into detail about what they would eat in times without corn. For example, one of the women said that 'my mother would cook cocoyam, *camote*, yuca with a bit of water and salt. Sometimes, we would only have a piece of coco for breakfast and piece of cassava for lunch. My mother would also do pudding from yuca or *camote*.' Other interviewees said that when they did not have corn, they would eat plantains and camote, and lots of fruits and vegetables.

Many people we talked to also said that they would collect *cohune* nuts (corozo palm) and sell them in the market. With the money, they bought food (usually flour and corn), or they used cohune nuts to feed the animals, geese and pigs, and sometimes to make oil for cooking. People also looked for work during the difficult times. Men sometimes worked for Mennonite farmers or they pulled wood from the forest with horses, and some women mentioned that they washed, ironed and cooked for other people, mainly in San Ignacio. The women were not usually paid with money, but rather they were given food, such as rice or wheat flour. Another source of income that was mentioned repeatedly was *chicle* collecting. According to one of our respondents, in 1937, the *chicle* business opened in Peten and after that, many people started to work as *chicleros* because it was possible 'to earn a lot of money that way'. Several farmers said that *chicle* collecting was their primary source of income, however, they only worked as *chicleros* during the rainy season. During the dry period, they farmed. The disadvantage was that during severe droughts, the tree sap dried up, so it was not possible to collect *chicle* and this source of income was not available.

In some extreme cases – for example, during the 1949 drought when many strategies failed to provide subsistence – villagers turned to government for help. If help was provided, this was mostly in the form of short-term contract labour, such as digging a new well outside the village or deepening the existing one, or clearing property lines for private landowners around the village. Any wages earned through labour or markets were used to buy food in San Ignacio or Benque Viejo. We asked our respondents if they would leave the village and go somewhere else if the drought would last a longer period of time. In several cases, people responded that they would not leave because they would not have money for moving somewhere else and the little there was would be essential for buying food until the new crop, so they would just stay at the same place and wait for the rain.

To deal with the swarms of locusts, various strategies were used. People said that the school's head teacher would send children to step on the locusts and people tried to spray them, but they said it did not work well. The government instructed villagers to dig ditches, sweep *chapulines* into them, fill them with gasoline and then light the contents on fire. One of the informants also mentioned that in one

of the cases he remembers, they were countrywide so an airplane was sent to spray the locusts. Another person observed that 'the problem was that sometimes people were scared to kill them, as some of them believed that it might be punishment from gods and that they have to suffer them. If not, it only will be worse and there will be more of them coming. So they only killed a few.'

The topic of locusts or *chapulines* turned out to be productive in the interviews, but some of the responses to our questions were contradictory with respect to whether the swarms were coincident with drought[7]. Some interviewees stated that they would only come during the drought because they had nothing else to eat. On the other hand, several people said that when *chapulines* came, it was actually a good year and corn was very nice and they came and ate it all, and everything else, including green thatched roofs. They added that in those years, they had enough water but not enough food due to cornfields being damaged by the swarms. Only the root crops, such as camote, macal, cassava or plants such as plantains would survive, so they would only eat those at that time. In fact, many of the strategies used to cope with problems caused by swarms were the same measures used during the time of drought. People relied more on fruit and vegetables, which could not be eaten by *chapulines*, they went hunting and collected cohune nuts, they looked for work in order to be able to buy food, or they were given food as payment by people they worked for. Two interviewees mentioned that, in some cases, government helped and gave families [five or ten] pounds of ground cornmeal per family.

After the questions about the droughts and other events, we also asked each person if they thought the weather had changed since their childhood and, if their answer was 'yes', in what way and when approximately the change had taken place. The almost unanimous response was that it had changed. Given the propensity of people to idealise the past, such a universal answer would normally lead to scepticism. However, when we asked people about the timing, there was a degree of consistency in that the change was relatively recent phenomenon, occurring within the last 20–30 years. In addition, with a single exception, everyone said that it had become hotter and dryer. The most important change, however, pertains to the timing and predictability of the rainy season. A common response, especially from farmers still practising agriculture, was that predicting the onset of the rainy season was much easier in the past, with variability in the order of days, before or after 15 April. Today, the rains are arriving later, in mid-May and sometimes even June, instead of April, and less reliably. Obviously, the onset of the rain is an important date for farmers because planting of corn must be coordinated with the arrival of the rain. For example, one of the farmers said that before the 1990s, they could count on the rains to come around the 15th of April, so they would plan the planting accordingly, usually a week or two before the rains would come. In the 1990s, it changed and since then, it has been more random. More recently, the rains typically begin in May or June, but it is very unpredictable: in 2010, it started to rain on 15th May and in 2011, when the interviews were conducted, it still had not rained by the last week of May. This interviewee, and several others, reported that such variability in the onset of the rains had affected the way they plant and now they simply wait for the rains to come and only then do they plant.

There was also one interesting coincidence in traditional knowledge. When we were talking about the current unpredictability of the weather with one of our interviewees, he recounted that at the beginning of the year, they used to record the weather for first 12 days in January and each day would represent the weather for each of the 12 months of the year. He said that when his father did this in the past, it worked, but now it does not, so it is impossible to predict anything. This same tradition exists in Slovakia where Jobbová was raised. Her grandparents used to do the same and even her parents know the custom. Besides geographical distance and obvious cultural differences, the two countries are in completely different environmental zones and have different seasons, so the fact that some traditional knowledge or customs are shared between the two is unexpected.

4.4.2. Arenal/Hydro Road (North Vaca Plateau)

Arenal is located south of Benque Viejo. Its settlement is split in two by the international border between Belize and Guatemala, which runs through the football field in the middle of the village. The village lies on Mopan River, which can be a helpful mnemonic of hydrological drought for Arenal's inhabitants. Arenal, along with Benque Viejo and Succotz, was reportedly settled in the 1860s by Maya refugees from Peten, although according to the marriage records at Benque Viejo, most of the people were originally from Yucatan who later came to the Peten (possibly after the Caste Wars), and some were born in Peten (Thompson 1988: 19). Several respondents reported settling there throughout the 20th century from different parts of Belize; others we interviewed were more familiar with the Guatemalan Peten. Although people reported, as they did in San Ignacio, that their fathers and grandfathers relied more heavily on subsistence farming and slash-and-burn agriculture than they do today, in many respects Arenal retains some features of the farming system that had already disappeared from San Antonio. For example, corn cribs were still used in Arenal but not observed in San Antonio.

As was the case in San Antonio, the 1949 drought was also mentioned in Arenal, although only by a couple of people.

[7] Locusts thrive during dry periods followed by rain and rapid vegetation growth, when the nutritional value of vegetation is increased due to concentration of sugars and nutrients, and the fungal diseases attacking locusts are reduced. Also, the heat accompanying the dry conditions accelerates reproduction and maturation of locusts and then, after the drought, they group together, feeding on areas of lush green vegetation and that population density is needed for the locust to transform into its migratory, swarming phase (Lockwood 2004).

Other years with severe droughts were 1960 (this might have been the same drought in 1959/1960 that people in San Antonio said lasted the whole year), 1973, 1975 and 2011. One of the oldest farmers in the village described a time when the Mopan River was nearly dry and the jaguars would come to drink water from it. Based on his timing, it was most likely the 1949 drought, which is also supported by the fact that he said that it affected all of Belize and lasted almost the whole year. He said that they planted the *milpa* four times that year but nothing grew, so they had to rely on food from the forest, such as mamey, chico zapote, heart of palm, and heart of cohune, to survive. They also went hunting for wild animals, such as crocodile and possum; some people also ate snakes. When we asked him if the way in which they planted, or what they planted, had changed after that drought, he explained that they planted yuca, macal and camote because these plants survive even in dry conditions. We heard similar stories from other people who said that they relied on coco and yams because they last a long time in storage, or that they ate plantains and had half a tortilla per day.

People also sought wage labour in order to earn money and buy food in the shops. Others reported earning money by selling cohune nuts, or making cohune oil and selling it in local markets. Yet another person mentioned that rice grew well around Arenal when there was less precipitation, but it was not profitable because the closest refining mills were located far away in Flores, Guatemala or in Big Falls, Toledo District, and rice buyers would not visit Arenal, perhaps because of its proximity to the Guatemalan border.

In Arenal, we also encountered interviewees who conflated historical drought and outbreaks of *chapulines,* however we discovered some evidence that they corresponded. When we asked one interviewee whether she remembered instances of drought, she immediately began talking about a time when she was around 10 years old and the *chapulines* came just as her father planted his last *milpa* before he stopped farming. He took his children with him to kill *chapulines.* We asked if it was a dry year or if it rained normally, and how the corn looked, and she said that the corn was very small due to lack of rain and they did not harvest much. In this case, although seemingly conflating the events, she provided a specific memory that corroborated a correlation between drought and *chapulin* swarms.

In addition to drought and *chapulines*, people in Arenal also mentioned floods and a fire. In one of the interviews, we followed the discussion about the drought with a question about whether the informant remembered another time when she had problems with the *milpa* and she said that there was a bad flood. She recalled being about 20 years old at that time and that it was in July, when the river rose and flooded houses and *milpas*. Almost everything was destroyed and they did not have food. She said that after the *milpas* dried up they planted again, but by that time, it was past the normal planting time, too late in the year, and the harvest was poor. It was also reported that a dramatic fire in 1962 burned the whole forest in the hills around the village after Hurricane Hattie in 1961. According to the interviewee, after the hurricane, the weather changed and farmers had to go much further from the village to farm.

As in San Antonio, people in Arenal also reported that the weather was hotter and drier now than during their childhoods. They pointed out that while in the past, people always planted in April, now they waited until May or June; and that the transition to hotter weather and later arrival of rains occurred sometime in the past thirty years.

We also conducted interviews in a series of 'pioneer' settlements located along the Hydro Road. Groups that settled here originate from different parts of Belize. The main reason for including this area in our study was because it was the closest contemporary settlement to the archaeological site of Minanha, and it is located at a higher elevation than the other study areas. It has been settled relatively recently, mostly since the 1960s, and it is now the site of the Mollejon and Chalillo dams. People living in this area are very familiar with their land and its potential but also with the problems it presents. Many people in other areas, such as San Antonio or Succotz, had switched to mechanised agriculture, however, according to one of the interviewees from the settlement close to the Chalillo dam, the rocky nature of the soil does not allow for ploughing, so he was still using traditional ways of planting, using an iron-tipped stick or *cana.*

As with the previous two study areas, the first drought that was mentioned was in 1949. One interviewee said that the rains came late, and when it began it was too late to replant. That year, they relied on coco and yams, as these root crops last a long time in the storage. In addition, wealthy people paid others to do some work for them. Another drought reported in this area was in 1959. According to our informant, during this period, collecting *chicle* was an important work opportunity. However, effective bleeding of the sapodilla trees (to collect the *chicle*) requires wet conditions because drought interferes with sap production. So, drought affected both subsistence and wage-earning potential. The next recollected drought was in 1973; another in 1989 was associated with the Black Rock fire, and years 2006, 2010 and 2011 were also identified as years of droughts.

As in the previous two areas, people along the Hydro Road also reported that the weather had changed since their childhoods — that it had become hotter and perhaps somewhat drier, with a prolonged dry period. The exact impact of drought on these families is difficult to assess, partially because they had ties with more established villages such as Benque Viejo with permanent water supplies and more varied skills for coping with drought.

4.4.3. San José Succotz

The village of San José Succotz is located on the banks of the Mopan River, northeast of Benque Viejo Del Carmen,

not far from Guatemalan Border. It is probably best known as the gateway village for accessing the archaeological site of Xunantunich, one of the most popular archaeological sites in Belize and a key source of income for the local economy. Succotz was also one of the case study villages that J. Eric S. Thompson used for his ethnographic study of Belize (Thompson 1930) in which he provides many details about agriculture, religion and folklore of the village. According to his notes, Succotz, along with Arenal and Benque Viejo, was settled by Mopan Maya from Peten and other Yucatecan Maya and Mestizos (Thompson 1988: 19; Wilk and Chapin 1990:12).

During Thompson's fieldwork in the 1930s in Succotz, subsistence agriculture was extensive, although as he points out, it was practised by individual families and not communally as in the Toledo District: 'Each family cultivates its own *milpa*, hiring outside labour at the rate of fifty cents a day when, and if, required. Each family rents land from the government' (1930: 115). The predominance of household labour may partly spring from the Succotzeños' historical Mopan Maya traditions as independent subsistence farmers (Wilk and Chapin 1990: 13). Today, there is little subsistence agriculture in Succotz; in fact, we encountered only one man who was actively planting *milpa*. Part of the reason for this is a change in land tenure: from relatively open access to Crown Land for nominal rent to legally-binding land leases, a process that has been underway in this part of Belize since the middle of the 20th century. This was an intentional process, instigated by the British to disempower the Maya villages, which they saw as a threat. The *alacalde* (mayor) was the centre of power, so they passed the first Village Council Act (1960s) to shift power from the *alcalde* to the village chairman, which was a political position (Bolland 1987). This pattern of diminishing subsistence agriculture aligns with the ongoing economic development of central and western Belize (Downey and Jobbová 2011).

Several historical droughts were remembered in Succotz and a few very elderly people mentioned severe drought around the year 1933. It was reported that a lot of cattle died that year, the harvest was very poor, and one of the respondents remembered that all people from the village gathered in church and prayed for rain. Another respondent related an incident during a hunt when one of the hunters found some fruit, the others fought with him, even trying to grab it out of his mouth because they were so hungry. The next few droughts remembered were: one sometime in the early 1940s (most likely around 1943), another long and severe drought in 1950 and one in 1956, the year after Hurricane Janet. The 1950 drought was referred to by more than one person as 'The Crisis', when corn did not grow and people actually fought over food. Water, on the other hand, did not seem to be a problem because of the close proximity of the Mopan River to the village.

People reported the many ways in which they dealt with drought, using a combination of subsistence and market-oriented strategies. As in other study areas, they relied on root crops, such as macal, *camote* (sweet potato), and jicama, which they often mixed with corn to augment the *masa* for tortillas, and foraged for wild foods, such as palmetto, heart of cohune palm, yuca, and payak. They fished and hunted animals, such as *tepezcuintle* (lowland paca), armadillo and deer, and often sold part of their game, using the income to buy food. People reported that they looked for work on ranches or collecting *chicle*. Ramon fruits were collected and boiled for *atole*, a corn-based drink, or to feed to the cattle, and cohune nuts were either sold or oil was made from them. In one case, the farmer pawned his two bulls to buy food, but he never got them back. At times, the government would provide staples, such as flour and sugar, and people reported that if the first planting failed because of lack of rain, they often tried to replant at least once. Most of the time, this was not successful or the harvest was very poor; most agreed that replanting was rarely worth the effort.

As in San Antonio and Arenal, people from Succotz also recalled the *chapulin* swarms. At least two instances were reported, most likely around 1943 and 1971, although these dates are only approximate because people expressed the time of events in terms of their age (e.g., 'it happened when I was about 10 years old'; some only said that it happened when they were young). However, these two years were also reported by several people from San Antonio and Arenal and given the relative proximity of the villages, it is very likely that *chapulin* swarms would have affected all three villages at the same time.

The effect of the *chapulin* swarms was described in similar fashion. People stated that the swarms damaged their fields, eating everything with green leaves, including corn, avocado, beans, and even green house thatch. The *chapulin* also ate all the grass on the pastures so people had to cut ramon leaves to feed their cattle. The way villagers dealt with the situation was similar to the strategies used in the other villages we studied. People described that they made trenches in which to put the locusts and then they burned them. Several respondents reported a lack of food during the period of the swarms and said that they survived on root crops (camote, macal), by mixing corn flour with macal, and also by hunting deer, armadillo, *tepezcuintle* and peccary. In one of these instances, however, it was noted that the swarms came late in summer (July, August) and by that time corn and beans had already matured, so only the husk and leaves of beans had been eaten and they could still save the fruit.

When we asked how the weather had changed since their childhood, there again was general agreement that there was much less rain now and that the rains started much later than they used to. We heard in every interview from Succotz that the first planting used to be in March on the day of San Jose (10th of March) and it was called 'la milpa de San Jose'. One interviewee observed: 'Now it is not possible to plant in March because it does not rain, so no one is doing the 'la milpa de San Jose' planting'.

One of our respondents summed it up succinctly:

> Now people do not start to plant until June and they are planting until July because they are waiting for rain. Also, in the past, people would use the corn from the previous year to plant, the corn used to be stored for a year or even two. Now people do not use the local corn, but the hybrid, which does not take that long to grow, but it cannot be stored, because it is soon spoiled by the *gorgojos* (weevils). Many people do not even want to plant anymore, because even those who do, do not have big harvest, so it is sometimes cheaper to buy things than trying to plant. I think that it is because the soil is tired, it does not have any minerals anymore and it is made worse because of the deforestation, which in turn causes there to be not enough rain. No forest, no rain (San José Succotz, 23rd June 2011).

Several people independently concluded that the change occurred within last thirty years or so, and one of the farmers mentioned a decreasing amount of water in the river, starting in the late 1970s. He knew this because there used to be a large amount of wood floating down the river in the past, this is not possible now because the water level is lower. Another person illustrated the fact that it rains less by pointing out that sometimes people had to move to higher ground during the rainy season (due to flooding, but it does not seem to occur anymore). She also said that in the past, when her children were going to school, the water was at times almost up to their waists on the streets and they had to cancel school.

4.4.4. Toledo District – Crique Sarco/Graham Creek

Crique Sarco is located on the Temash River in the southern part of the Toledo District, approximately 20km (as the crow flies) from the Caribbean (Fig. 4.1). It is reportedly one of the oldest Q'eqchi' villages; there are several possible versions of its initial settlement. The details of the stories, as well the settlement histories for other villages in the southern part of the Toledo District were documented in Downey (2009, 2015), and an ethnohistorical overview of the settlement of the entire Toledo District can be found in *Household Ecology* (Wilk 1997). The earliest settlers were most likely Q'eqchi' Maya from the village of Dolores, who originally came from the Alta Verapaz region in Guatemala after they fled the country when a *mandamiento* (law) was codified in Guatemala in 1877. The *mandamiento* allowed the Guatemalan government to confiscate untitled indigenous lands and instituted a forced labour system that mainly benefitted wealthy landowners and foreign producers, particularly coffee growers from Germany (Wilk 1997). This process forced many to flee from the Guatemalan highlands to the more remote areas of the Peten and to southern Belize (Downey 2015). Graham Creek was settled much later, in the 1980s. Because of its proximity to Crique Sarco (about a 1.5 hour walk), its inhabitants share many kinship and economic ties. For the comparative purposes of this study, it is important to remember that Crique Sarco and Graham Creek originated during different waves of settlement than that in the Cayo District. In addition, historically, the Toledo villages were somewhat less exposed to British Colonial oversight and the district is characterised by many cycles of economic development and neglect (Wilk 1997).

As in the Cayo District, we asked people in Crique Sarco and Graham Creek if they remembered any droughts and how they were affected. Several informants then described years when 'the corn died', however, it soon become obvious that the majority of the events they were describing were agricultural droughts, which only affected the growth of crops, rather than hydrological ones like the ones that were reported in the Cayo District. In addition, with a single exception, the dates of the drought episodes were given in an indirect way (i.e., 'when I was about 8 years old, the corn died') and the descriptions of the events were less specific than those from Cayo. Based on the ages given, one longer drought that was mentioned more than once may have occurred in 1951, although it is very likely that they, in fact, meant the severe 1950 drought mentioned by people in the Cayo District. Another problematic year fell in the middle of the 1960s (1966–1967), and there were also two separate drought episodes, mentioned by four different people, when everything was covered by ash. One event was dated to the early 1980s and the other to the late 1990s, which might correspond with the eruption of the Pacaya Volcano in 1998 (Volcano Discovery). Finally, as in all the previous areas, 2010 and 2011 were described as very dry, and one of the respondents pointed out that 'the water in the well has never been as low as it is now'.

In general, there were fewer and less specific reports of severe droughts in Crique Sarco and Graham Creek, which is perhaps due to the fact that precipitation in the Toledo District is substantially higher than in Cayo. This environmental difference might also explain why none of the people we interviewed reported to have ever seen swarms of *chapulines* in this area, and only three respondents said that they heard about them from their parents long ago.

During periods of environmentally-induced stress, people reported similar coping strategies as in the Cayo District. Hunting and gathering activities increased, they relied on root crops and mixed corn with grated cassava or plantains to augment *masa* for tortillas. Replanting was also mentioned, with better results than in the Cayo District, most likely because the droughts did not extend into the dry season. People reported buying corn and rice and also looking for work to earn money to buy food. One difference from the Cayo District was that no one mentioned markets or government assistance. This was probably because the nearest market town and local seat of government is Punta Gorda and during much of the twentieth century, the main access route was an arduous and dangerous river journey or long walks through the forest.

Despite the less frequent reports of droughts in Toledo, a change in the weather was unanimously acknowledged. People reported that it was hotter and drier than it used to

be, with a delayed rainy season. This change was illustrated by the fact that the inhabitants used to plant in April but now they have to wait until June for the rains to begin. Answers regarding the timing of the change varied from three to up to 40 years ago, with two respondents saying, as was the case in the Cayo District, that the weather began to change approximately 30 years ago. The most frequent answer was that it had changed five years ago.

4.5. Contemporary religious practices related to drought

Maya rituals and ceremonies related to swidden agriculture have been documented in both Toledo and Cayo districts (Tzul 1993; Wilk 1997; Haste and De Ceuster 2001; Grandia 2004), so we were interested in identifying specific rituals and ceremonies related to drought and other types of

Table 4.1. Common names of plants and animal species relied on during drought

San Antonio	Arenal	San José Succotz	Crique Sarco/ Graham Creek
Plants			
macal (*Dioscorea alata L.)*	macal (*Dioscorea alata L.)*	macal *(Dioscorea alata L.)*	macal (*Dioscorea alata L.)*
cohune nuts *(Orbignya cohune)*	heart of cohune cohune nuts *(Orbignya cohune)*	heart of corozo (cohune) *(Orbignya cohune)*	
ramon fruit *(Brosimum alicastrum)*	ramon fruit *(Brosimum alicastrum)*		ramon fruit *(Brosimum alicastrum)*
coco (taro) *(Colocasia esculenta)*		coco *(Colocasia esculenta)*	coco *(Colocasia esculenta)*
	yuca (cassava) *(Manihot esculenta)*	yuca *(Manihot esculenta)*	yuca *(Manihot esculenta)*
potatoes *(Solanum tuberosum)*	camote (sweet potato) *(Ipomoea batatas)*	camote *(Ipomoea batatas)*	camote *(Ipomoea batatas)*
palmetto *(Schippia concolor)*	palmetto *(Schippia concolor)*	palmetto *(Schippia concolor)*	
yams *(Dioscorea L.)*			yams *(Dioscorea L.)*
huano fruit *(Sabal mauritiformis)*	huano fruit *(Sabal mauritiformis)*		
chico zapote *(Achras zapota L.)*	chico zapote *(Achras zapota L.)*		
pacaya *(Chamaedorea tepejilote)*	pacaya *(Chamaedorea tepejilote)*		
'cucut' *(Allium cepa L.)*	plantain (*Musa paradisiaca L*), mamey (*Pouteria mammosa)*, manash *(Pseudolmedia spp.),* heart of palm *(Acrocomia Mexicana)*	coconut (*Cocos nucifera L.*), jicama *(Pachyrhizus erosus L.)*	rice (bought) (*Oryza sativa*),
Animals			
		armadillo *(Dasypus novemcinctus)*	armadillo *(Dasypus novemcinctus*)
	gibnut (tepezcuintle) *(Cuniculus paca)*	tepezcuintle *(Cuniculus paca)*	tepezcuintle *(Cuniculus paca)*
deer *(Mazama americana/ Odocoileus virginianus*		deer *(Mazama americana/ Odocoileus virginianus*	
	peccary *(Tayassu tajacu)*	peccary *(Tayassu tajacu)*	
pigeons *(*Columbidae*),* goat *(Capra aegagrus hircus)*	snakes (Serpentes), crocodile *(Crocodylus moreletii)*, possum (*Didelphis marsupialis/ virginiana),* iguana *(Iguana iguana)*		fish *(Osteichthyes)*

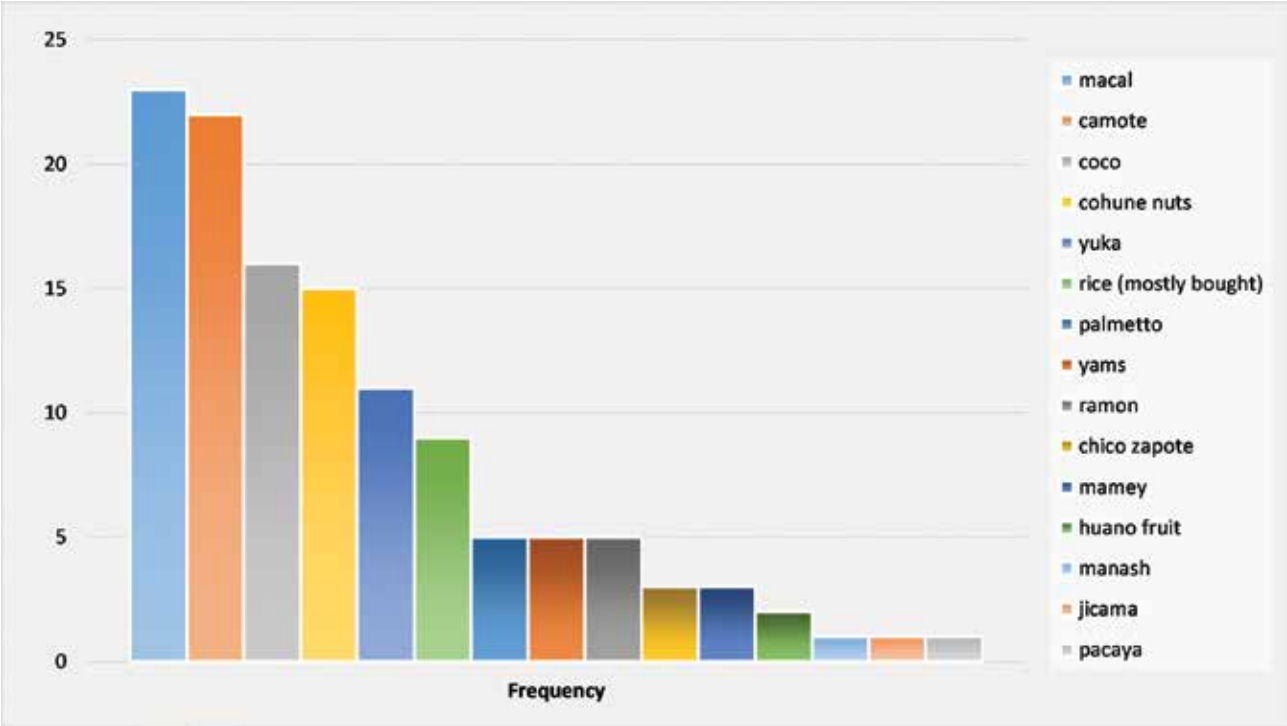


Figure 4.2. Relative importance of various plants during droughts, based on number of interviews they were mentioned in.

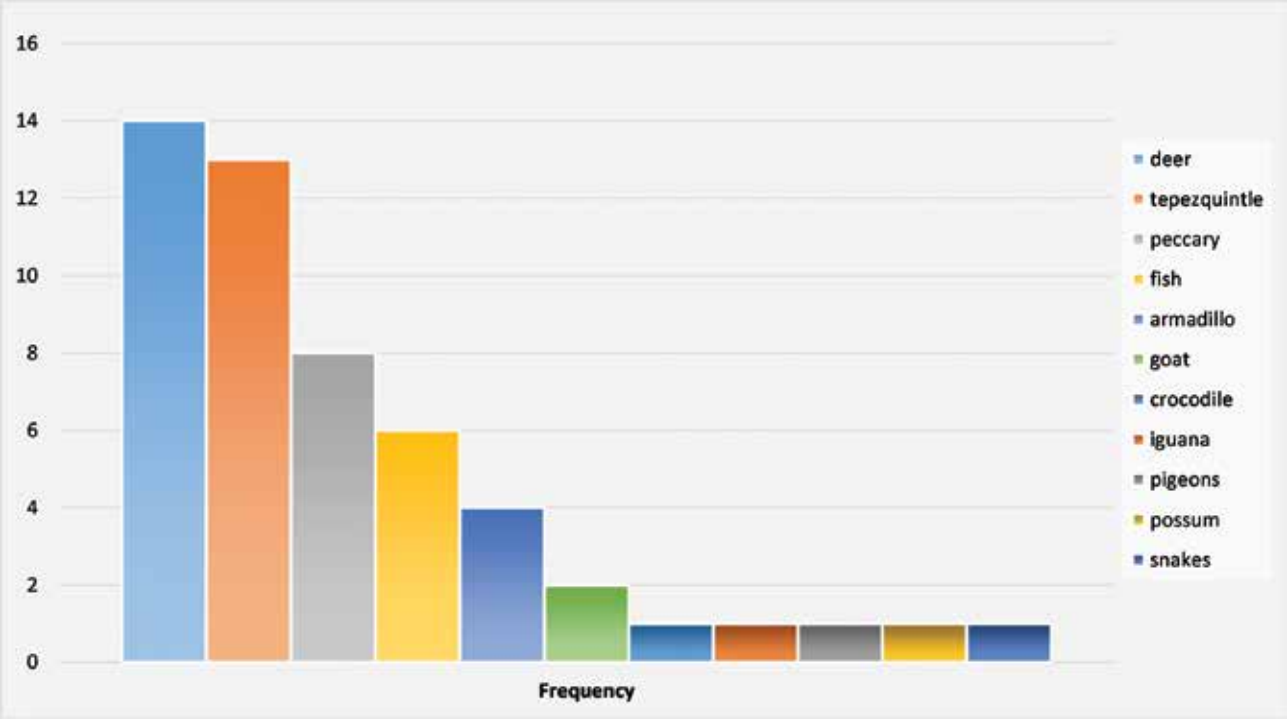


Figure 4.3. Relative importance of various animals during droughts, based on number of interviews they were mentioned in.

environmental stress. 'Rain-making' is an old theme in the anthropological literature (e.g., Frazer 1911; Butree 1930), so we investigated evidence of similar practices existing in Belize in the 21th Century. After asking about droughts, other stress-inducing environmental events and coping strategies, we asked whether the interviewee recalled any specific ceremonies were performed to mitigate the effects of any of the reported droughts. By posing the question this way, we attempted to avoid hypothetical answers to see if the informant actually had seen or participated in drought-related rituals.

When Spanish missionaries introduced Christianity to their regions, the Maya, instead of abandoning their gods and beliefs, incorporated Christian elements and grafted their own customs and beliefs onto Christianity (Graham

Table 4.2. Comparative table summarising ethnographic interviews

	Arenal	San Antonio	San José Succotz	Hydro road/Vaca Plateau	Crique Sarco	Graham Creek
Drought	1949, 1960, 1973, 1975, 2011	1910, 1935, 1949, 1961, 1965, 1973, 1995, 2010, 2011	1933?, 1943?, 1950, after hurricane Janet (1955)	1949, 1959, 1960, 1973, 1989, 2006, 2010, 2011	1950/51?, 1951, 1966–67?, early 1980s, late 1990s (possibly 1998), 2010, 2011	Early 1950s (1951?), 60s–70s, 1998, 2010
Chapulines		1938, 1940, 1941, 1944, 1971	1943?, 1971?			
Onset of the rainy season	Later (2)[8]	Later (3)	Later (3)	Later (1)	Later (1)	
Long-term change in weather patterns/ climate change	Less rain, much hotter (3)	Less rain now (10); less rain, hotter (3); less predictable/ unpredictable (2); longer dry season (2) - until May or June rather than April as before (1); more rain than before (1); it rains a lot during the hurricane season (1)	Less rain now (5); less rain and hot (1); less water in the river (2); more storms, hurricanes and floods, but not enough normal rain (1); changed/late rainy season (3); It is the same (1)	Less rain - much hotter (2); longer dry season	Less rain (1); less rain, hotter (4); less rain, less water in river (1); too much sun, longer dry season (1)	
Timing of the perceived long-term change in weather patterns	After hurricane Hattie 1961; 30 years ago,	4 years ago; 5 ya.; 10 ya.; 15 ya.; 30 ya. (2); 40 ya.; changed in 1990s; started to change in 1985 (1)	15 years ago; 30 ya. (1); changed after hurricane Hattie 1961 (2); changed in 1970 (since then much lower river water levels)	10 years ago; 15 ya. (after building Mollejon dam)	8–10 years ago (after volcano eruption); 5 ya. (2); 3 ya.; 8 ya.; 30 ya.; 'Long time' ago	20 years ago; 40 years ago; 3 years ago (2)
Planting times in 2011	May 22 – not planted yet	Planted in April (not growing, waiting for rain) (2); not planted yet (on 11th of June); waiting for rain (2); planted on 26th May, but not growing well, waiting for rain (1)	Planted on 15th May; planted before 20th May, it did not grow, had to plant again at the beginning of July	Planted on 22nd April and 18th May (did not grow, waiting for rain)		
Changed planting season	Used to plant in April, now in May or June (1)	Used to plant in 15th May (1); used to plant in April (2), now in June (2); used to plant on 3rd May (2); used to plant in April and May, now waiting until June and sometimes July (1); changed to mechanised planting - using hybrid corn so planting whenever (1); in the past planting in February and March and then again in June (1)	Used to be 2 plantings, first in March, the second in May, June, now no one is doing the planting in March, only in June (2); first planting used to be on 19th March (Milpa de San Jose), the second on the 25th of April or 3rd of May, now planting mostly in June until July (2)	Used to plant in April, now waiting for rain until June	Used to plant in April (May), now in June (4)	Used to plant in April, now in May or Jun (1); all planting used to be finished by 10th of May (used to have more harvest when planting in April)

(*continued*)

[8] Numbers in brackets represent number of individual responses.

Table 4.2. (*Continued*)

	Arenal	San Antonio	San José Succotz	Hydro road/Vaca Plateau	Crique Sarco	Graham Creek
Ceremonies	N/A – did not ask about that	Carrying *atole/posole* to *milpa* placing in on *tapesco* (table/altar), often in 9 *calabashes* (bowls) (6); went to church to pray for rain carrying sweetened rice or *atole* (5); taking saints out from church and carry them around, put it on the table and small children underneath the table imitating frogs (1); placing offerings (*atole, saca*', porridge..) on the table and calling *Nuukuchtat* (4); 12th of June – washing the stone/ washing the statues in the church and praying for rain (2); Novenas or 'to comprar lluvia' – bringing offerings (drinks – sweetened rice, *saca', Xpasah*) and praying for 9 days (4); Processions around the village praying for rain (1); asking saints for rain (1); making large tortillas of several layers cooked underground on hearth with 9 stones representing tribes of Israel (1); putting statue of San Antonio out on the sun until it sweats and then pour water over it (2)	Putting the food and drinks on *tapesco* either at home or in *milpa* and praying for rain (2); Novenas (paying for rain in church for 9 days (3); procession with San Jose statue around the village praying for rain (3); preparing a lots of food and drinks and bringing it to church and pray for rain (1); Primicia - praying to god for rain (1); filling *calabashes* with *atole* and placing them in 4 corners of the *milpa*, then praying (1); filling *calabashe*s with *atole* and praying both to Maya gods (*dueño del monte, del aqua*…) and Catholic god (1)	N/A – did not ask	All men would gather, fast, bath, and be celibate for 3 days, then burn incense and pray (2); taking saint from church and bathing it in the spring and pray for rain to come (3); *Maya Hak* - offering to *Tzultaq'a* (3); fishing by, poisoning fish using *cha'lam* leaves (2); bathing black cat in the water (2)	Maya *Hak/Chak*-offering to *Tzultaq'a* (1)

'Superstitions'		End of the world is coming; *Chapulines* are punishment from gods and that they have to suffer them so people are afraid to kill them	People do not believe in ceremonies anymore so they do not work; many religions, people do not care if it's raining or not, no one is believing in traditions anymore; If you do not do it properly and you do not finish the whole cycle something bad can happen to you. But if done properly '*dueño de la milpa*' will take care of your *milpa* and you will have a good harvest; cannot do the Primicia again because his sons do not believe in it; if he tried to do it anyway, something bad could happened to him		Customs dying out because of education; elders who do it now don't do it properly so it does not work; different religions – village is divided – that's why they are suffering, it will get worse.	

2011; Thompson 1954: 5; Wisdom 1952: 120). According to Thompson (1930):

> The nominal religion of the Mayas of Socotz [*sic*] and the neighboring village is the Roman Catholic faith. Nevertheless their Christianity, like that of their fellow Indians in the Toledo District, shelters within its somewhat expansible bosom a good deal of the degenerate remains of the old Maya religion. They, too, are at heart polytheists. The Christian god is the Zeus of the Pantheon. The Virgin Mary, the Saints of the Catholic church, and such of the old local gods as have survived, form a less powerful, but more friendly group of divinities (Thompson 1930: 106).

The situation has changed, however. After the surge of Protestant proselytisation efforts and subsequent conversions in the 1960s, large proportions of Maya villages adopted conservative forms of Protestantism, which is not as accommodating as Catholicism to the retention of customs related to traditional folk religions, and instead requires abandoning any vestigial 'pagan' beliefs. In many indigenous communities such as Crique Sarco, the village is split by different denominations of Christianity and, interestingly, some people we interviewed blamed the current trend of hotter, drier weather and less predictable rains on this lack of social cohesion. Others thought that dry weather was the fault of village elders, who did not know how to perform the rituals correctly or failed to adhere to the ritual obligations for cleanliness, abstinence and conscientiousness. The split also meant that people who converted to Protestantism were reluctant to discuss any type of ceremonies involving old Maya gods or beliefs, or in some cases said that they used to do it in the past. Despite this, people both in Cayo and Toledo reported a surprising variety of rituals that could be used during the periods of drought, some of them performed only up to the mid-20th century and some, in the Toledo District, still performed today.

4.5.1. Drought rituals in the Toledo District

Ceremonies and rituals in Toledo usually involve *Tzuultaq'a,* mountain spirits who are also called *dueños* or owners and to whom one prays and makes offerings. They have different names, representing names of the mountains in the four corners of the earth (*Kawa Xocaneb, Kaw Sanjil, Kaw Caxlan keh, Kawa Progress*). *Tzuultaq'a* in the Q'eqchi' language means 'valley of the mountain', also described as a place 'where our ancestors are'. In each village there is a place, usually a cave or a spring, which is considered to be the home of the *Tzuultaq'a*, and people (in most cases, only men) go there and make offerings and pray for what is needed (Fig. 4.4). However, ceremonies can also be carried out in houses*, milpas*, or in the village's church (although this was more often mentioned in Cayo than in Toledo). The most commonly described ceremony that could be performed on various occasions, including drought, was

Figure 4.4. Offering to Tzuultaq'a in Toledo (photo by Sean Downey).

one where the village elders (men) gathered before the ceremony for a three-day period of fasting, abstinence and cleansing, after which followed the ceremonial burning of candles and incense either at home, in the *milpa* or in *Tzuultaq'a* place. Sometimes, the ritual included burying of ground cacao and meat or killing a turkey, which they would then cook and offer to the *Tzuultaq'a*. During the ceremony, women usually stayed in church and prayed while waiting for the men to return, after which everyone would eat.

A more drought-specific ceremony was recounted as follows: if the drought lasts a very long time, the statue of a village's saint is taken from the church and 'bathed' in a spring that has not dried up. Alternatively, the saint is placed in front of the church and water is poured over it, while people pray for rain. The majority of people we interviewed said that they only heard about such ceremonies from their parents, that they participated in them when they were young, or that they would not perform these rituals again because they changed their religion. However, there are still some people who perform these rituals even today. While we did not witness any, one of the farmers we talked to said that because it was already late in the season (June) and it had not rained yet, he might wait for another week or so, and if it still had not rained, he would perform the rainmaking ceremony. Not everyone in the village seems to be convinced that these ceremonies still work, however. People reported that while in the past the whole community was involved in these rituals, nowadays only a small number of families or individuals perform them, and young people seem to be less interested. In fact, some people see the problems with the hot and dry weather as the consequence of these changes. According to them, the village is divided by different religions so not everyone is involved anymore; and people who perform the rituals might not know how to do them properly, or do not observe all the obligations, so the rituals do not work anymore.

There was another rain-calling ritual mentioned, although this one seems to be performed individually rather than by the community. This was a ritual, reported by several people, that involved fishing and the release of the poison from the *ch'alam* plant into the water of small creeks (the practice was also documented earlier by Grandia 2004). First, the leaves are beaten on rocks then put into the creek; the poison seeps into the water and the fish are paralysed by the toxins. The fish then float up to the surface of the water and can be easily collected. Fortunately, the poison is non-toxic to humans. It could be reasoned that this manner of fishing is a normal, pragmatic response to drought conditions, as it would only be effective when the creek water level is low. However, our respondents suggested that poisoning fish was a way to encourage rain during a drought and these fishing events were sometimes accompanied by offering a burning candle attached to a cohune leaf for the *Tzuultaq'a.*

4.5.2. Drought rituals in the Cayo District

Although there are similarities between the rain-making rituals described in the Toledo and Cayo districts, those from Cayo seem to have more variations and some features that were not mentioned in Toledo. Some of the rituals in Cayo also involve the mountain spirits, which are here called *Mam* or *Huitz-Hoc* (Thompson 1930) or, most commonly in our interviews, *Nuukuchtat,* but people also referred to them as *dueño de la milpa*, *dueño del agua* and *dueño del monte.* The most frequently described ceremony was again a somewhat general-purpose agricultural one, which in some ways resembled the one reported in Toledo, with some additional elements. During the drought, people would prepare the drink and/or food offering and carry it in nine calabashes, or bowls made from bottle gourd, to the *milpa* or to the church, where the table called *tapesco* was prepared for the calabashes. They would leave the offerings for *Nuukuchtat* there and then, later in the afternoon, they would come back and take the offerings and share them with people in the village.

Several different drinks were mentioned in the interviews. One is *posol* or *posole*, made from ground corn soaked in lime water, which is then boiled and mixed with sugar or honey. Another version is called *saca',* which is prepared similarly, but without soaking the corn in lime water. Yet another drink mentioned is called *xpasah*. Corn is soaked for two days in water, then it is ground, water is added to it and the liquid is left to ferment. After that, it is strained and cooked. Some people add sugar to it and others add salt. Many people also mentioned a sweetened rice drink.

There are several variations of the drought ritual. For example, several people added that small boys crouched under the *tapesco*, imitating frogs (Fig. 4.5). Then there were rather Catholic versions of the ritual: one is called *Rosario*, which also involves the sweetened rice drink, but the drink is carried to the church, put on the altar and people then pray for rain in the church. Another version is called *comprar lluvia* (to buy rain) or *novenas*: people gather at church every day for nine days in a row and if it did not begin to rain, another nine days would be added and then another nine (three *novenas*). The number nine was common in the rain-making rituals in Cayo: in an alternative description of the ceremony (please see the description below **on p. 46**), nine bowls, nine cobs of corn, nine layers of tortilla (13 inches in diameter) and nine stones in the hearth seem to represent nine Maya gods to whom the offering is made. In another interview, the respondent suggested that the nine stones in the hearth represent the Israelite tribes. *Novenas* were not talked about by name in Toledo, and nothing resembling numeric repetitions of cosmologically significant numbers was ever mentioned. On the other hand, there were no references made to burning copal incense in any of our interviews in Cayo. Some of these differences might reflect their ethnic background, the original religious beliefs and ritual practices of the areas they came from.

One ritual that was described in an almost identical way both in Cayo and Toledo was the 'bathing of the saint'. If it did not rain, the village's saint was taken from the church and bathed in water. In Cayo, one interviewee also described how they left the statue out on the sun until the

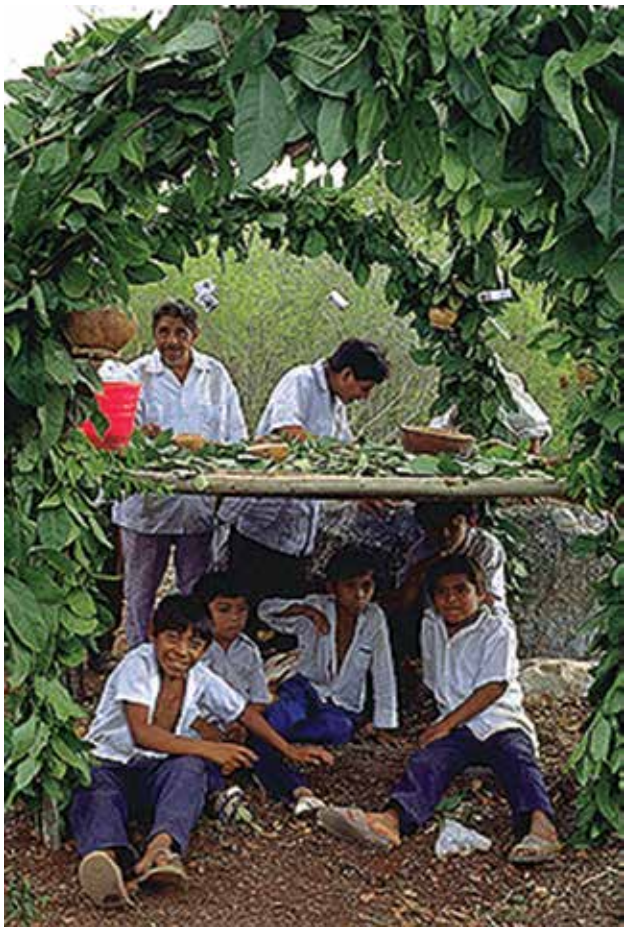


Figure 4.5. Offering of food and drink on *tapesco*, and boys crouched under this table/altar, imitating frogs during rain-calling ceremony in Cayo (photo Lara Beccerra Roma).

stone started to sweat and then they poured water over it. According to the people we interviewed, more elaborate rituals taking place in *milpas*, involving *Nuukuchtat* and the cosmologically significant numbers, were only performed until the 1960s. More recent rituals, like processions with saints around the village or *novenas* and drink offerings in church seem to be ones heavily incorporated into the Catholic religion. However, even these ceremonies do not occur now according to interviewees. When people in Cayo complained about the current drought (2011), we asked what they are going to do and if anyone was still performing the rain-calling ceremonies. They said that they would just wait for the rain, that no one was doing these rituals anymore – only their grandfathers and, in some cases, their fathers used to do that. Additionally, when people described the ceremonies, very often there were complaints: 'People had a lot of faith then and prayed from their hearts, so it worked', implying that people did not believe in these rituals anymore, which is why they did not work and, therefore, no one was performing them. Another example came from one of the farmers, who said: 'No one is doing the *primicia* (another agricultural ritual) now, so all these animals (rats, parrots, coatimundi) are damaging plants at the *milpas* because *Nuukuchtat* does not take care of them anymore.' When we asked the interviewee if he would consider doing the *primicia* again to save his *milpas*, as he told us he used to do in the past, he answered that he cannot do it again because his sons do not believe in it and he is afraid that if he tried to do it anyway, something bad could happened to him. He added that maybe he would only do it if he lived alone.

The description of ceremonies related to the whole swidden cycle (including the rain-making ritual), which were still performed from 1950 to 1960, were recounted to us by one of our informants as follows:

> At times when it does not rain, the old people would use rain ceremonies. I don't know about the more ancient ones, but I do know something about those that were still performed up to 1950–60. They were doing offerings to their gods. There are nine of them. Owner of the land, owner of the forest, owner of the springs, roads and animals, … each has its owner or protecting spirit. There are nine divine beings looking after the entire agricultural cycle. So when they would do the ceremony before cutting and burning the *milpa*, they would select nine cobs of corn, the biggest ones they could find. Then they would make *posole* and sweeten it with honey or sugar. Then they would select nine *calabashes*, eight of them would be uniform of approximately 5 inches in diameter and the ninth one would be a small one for the chief god, who they call *T'uup*. Then they would line up the *calabashes* in the east-west direction so the priest could face north. They were very faithful doing this and did it before burning the *milpa* and also before planting, then they would wait until the corn would grow and be green and make another, different ceremony. They would select a bucket of green corn (again the biggest one they could find) and make a drink called *saca'* as an offering. For this drink, they will take a dry corn and soak it in water overnight until it is soft and make the same offering, carrying *saca' al monte* and putting it on the *tapesco*. And they would to this before they eat the green corn. They chose the date, 3rd of May, which they call Santa Cruz day and on this day, they would wait for the rain. If rain didn't come until June, they would perform the rain ceremony (this ceremony comes from the north from Pachacan, and they call this ceremony *Ch'a chaak* [referring to *Chaahk* , the ancient Maya rain-god]). For the ceremony, they make a really big tortilla about 13 inches in diameter and cover it with beans and ground pumpkin seeds, then they cover it with another tortilla and make nine layers like this. Then they bake the tortilla in a special hearth formed with nine stones. Once it was baked, they would set up the altar (*tapesco*), and put on it nine cobs of corn and the tortilla, and three or four little boys would sit beneath the *tapesco*, jump around and imitate frog sounds. Immediately after the ceremony it would begin to rain (12th June, 2011, San Antonio, Cayo).

4.5.3. 'Superstitions'

Our observations about what could be called 'superstitions' were related to individual perceptions and interpretations

of climate and weather-related events. After several interviews, it became obvious how differently some events related to weather and environment could be perceived, interpreted and acted on, based on subjective observations of people. There were several occasions when events, such as lack of rain or the swarms of *chapulines* were explained as being due to supernatural causes. For example, when we questioned people about the drought-related rituals, several people saw the changes in weather patterns as being a result of the lack of social cohesion and erosion of ritual knowledge. One person said: 'There are many different religions now and the village is divided, that is why we are suffering now. Young people do not do the rituals anymore, and people who still do, don't do it correctly, so it does not work. … They are not clean, they do not fast. No one knows what is going to happen, we will suffer more, the worse times are coming' (3rd June, 2011, Crique Sarco, Toledo).

A very similar observation was made by Alicia Re Cruz (1996: 53) among the Maya community from Chan Kom, a village in North-Central Yucatan. 'For the people of Chan Kom, La Canicula of 1989 was 'the most severe drought they remember in the last 25 years.' They believe that divine intervention was playing an important role, intensifying the crisis by sending the drought: 'No esta bien; Dios no le gusta que estemos asi, odear los unos con los otros' (This is not right. God does not like to see us like this, hating one another).'

Similarly, the swarms of *chapulines* in the Cayo District villages were perceived by some people to be a punishment from gods. 'People were trying to kill them so they dug a big ditch and wanted to burn them. But sometimes people were scared to kill them, some of them believed that it might be punishment from gods and that they have to suffer them. If not, it only will be worse and there will be more of them coming, so they only killed a few' (23rd June, 2011, San Jose Succotz).

In another case, the lack of rain was blamed on the construction of Mollejon dam and the power lines in the valley: 'Since they built the Mollejon dam, it rains much less. Or, it even looks like it is going to rain but then it goes around. Maybe it is caused by all those electrical cables from the power station' (23rd May, 2011, Martz Farm by the Mollejon dam, Cayo).

4.6. Comparing people's perceptions and the rainfall data

People are known for idealising the past and perceiving events subjectively. This tendency has been noted in research that examines the difference between *perceived* and *measured* weather and climate (Goebbert et al. 2012; Howe and Leiserowitz, 2013, Wanyun Shao 2015). For example, Howe and Leiserowitz (2013: 12) state that while in general people are able to recognise the change from normal temperature or precipitation patterns, especially during more recent seasons, the recollection of whether they were warmer or colder than normal may be biased depending on preexisting beliefs about global warming. In order to gain further insight into historical changes in weather and climate in our two study areas, we examined meteorological data from local weather stations, looking at the spatial and temporal variations in rainfall. We were interested in inter-annual variability in rainfall, that is, if and how the amount of annual rainfall changed over time. Perhaps even more importantly, we aimed to examine intra-annual (or seasonal) variability, reflecting the change in the monthly distribution of rainfall. In the humid tropics, seasonal variability affects the timing of the onset of the rainy season. As discussed in the introduction to this chapter, the predictability of the onset of the rains is important for farmers because the planting of corn must be coordinated with the arrival of the rains. In exploring spatial variability, we were interested in the differences in rainfall patterns and their changes over time between the two study regions.

Recording of precipitation in Belize goes back to 1866, however, not all station records go back that far and there are gaps in the records for individual stations. For both study areas, it was possible to compile a precipitation sequence from 1935 to 2005. The data were generously provided by the Belize Department of Meteorology in July 2005; data were compiled by Sean Downey. For the Cayo District, we used daily rainfall values collected at the weather station located at Central Farm (approximately 20km from San José Succotz). For the Toledo District, we used daily rainfall values from the Punta Gorda weather station (approximately 60km from Crique Sarco).

4.6.1. Summary of rainfall data analysis

The results of the analysis and the rain charts presented below indicate that at least some of the ethnographic observations of changing weather patterns are supported by historical meteorological data. The later onset of the rainy season in both districts is indicated in Figures 4.6 and 4.7, which show decreased rainfall in April and increased rainfall in May after the late 1990s. This is also supported by Figure 4.8, showing some evidence of the delayed onset of the rainy season in the Cayo region, especially for the period between 1996 and 2000 (bright red colour). The general trend in cumulative rainfall shows a small increase in the middle of April, representing the earliest rains, and a sharper increase at mid- to end of May, corresponding with the proper onset of the rainy season. However, the period between 1996 and 2000 shows onset of the rainy season in June, rather than in April or May as in most of the earlier periods (except for the extremely dry period between 1971–1975, bright blue colour). The later periods (1991–2004) also show that there was less rainfall in the Cayo District during the normally wettest months of June and July[9]. The reduced rainfall in the wettest months is also indicated in the Toledo District in Figure 4.9 for the

[9] June and July are the wettest months during the first planting season and also within the year in Cayo and Toledo districts, however, in some districts the wettest months within the year are September and October, e.g., Stan Creek and Belize district.

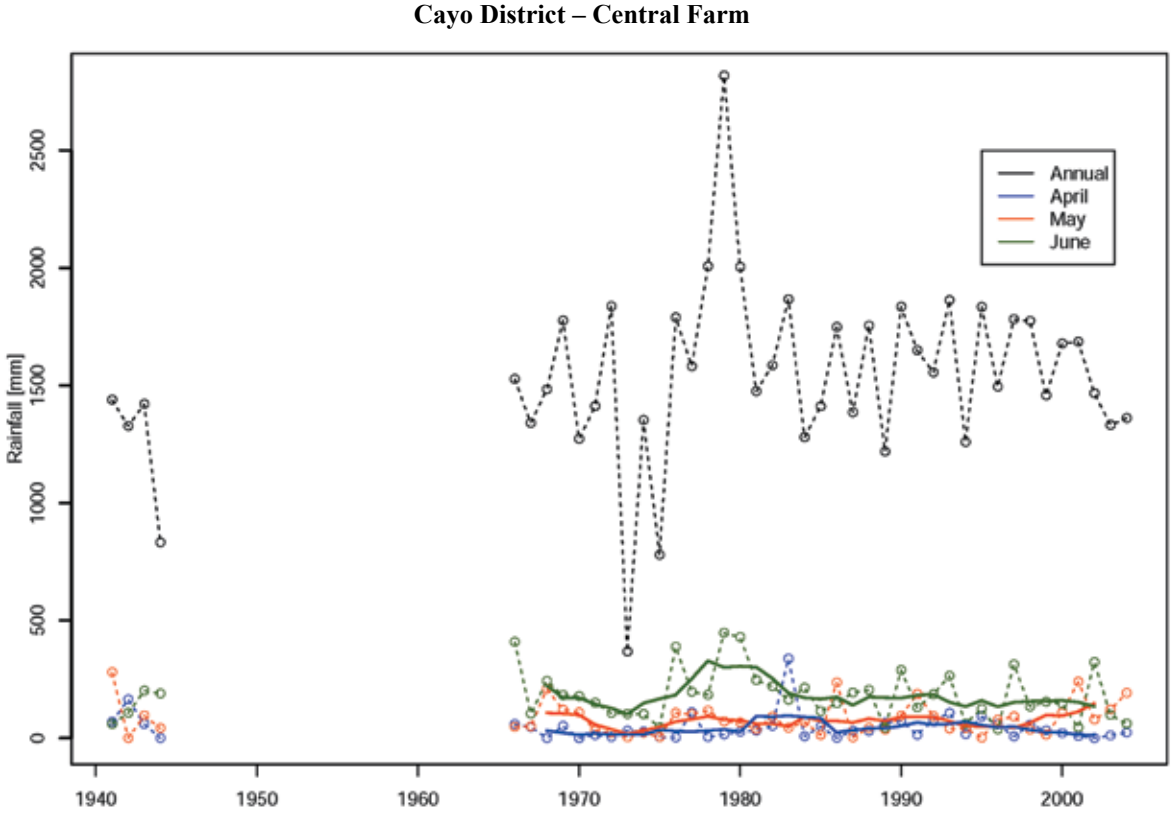


Figure 4.6. Cayo District – Inter-annual variability of rainfall, with black dashed line representing annual values[10], and coloured lines representing values of rainfall in the months of April, May and June (the full lines represent moving average values over 5-year periods). Note the decrease in April precipitation (blue) and increase in May precipitation (red) from about 1997 onwards.

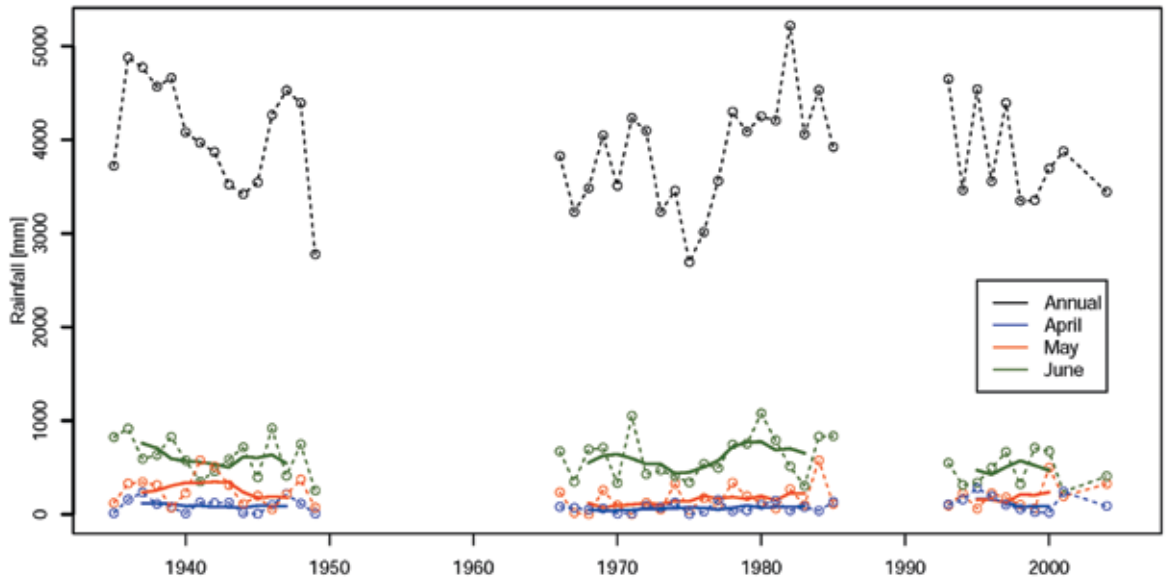


Figure 4.7. Toledo District – Inter-annual variability of rainfall, with black dashed line representing annual values, and coloured lines representing values of rainfall in the months of April, May and June.[11] Note the decrease in April precipitation (blue) and increase in May precipitation (red) from about 1997 onwards.

[10] Some values of annual rainfall are only approximations because in a small number of cases (years 1942, 1970 and 1973), the rainfall data for some months are missing. Mostly these are the months with the least amount of rainfall (e.g., January, February, December), so it does not significantly affect the overall results.

[11] Some values of annual rainfall are only approximations because in small number of cases (it is the case only for the years 1992 and 2002), the rainfall data for some months are missing. Mostly these are the months with the least amount of rainfall (e.g., January, February), so it does not significantly affect the overall results.

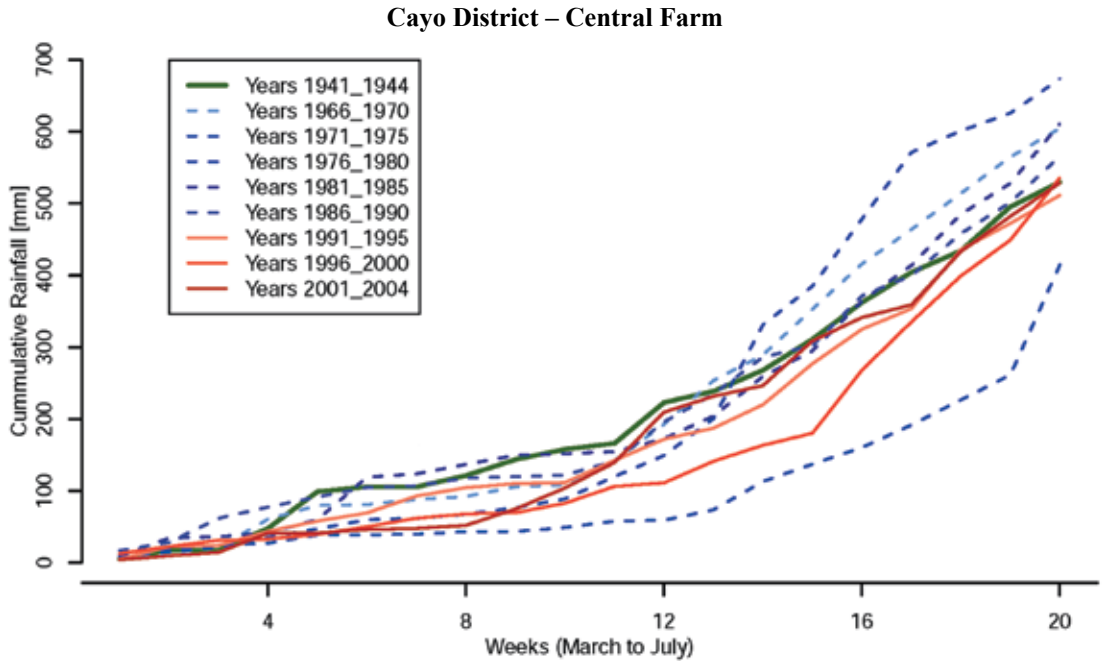


Figure 4.8. Cayo District – Cumulative rainfall for the period March–July, in 5-year intervals (except for 1941–44)[12]. Note the delayed onset of the rainy season in the Cayo region, especially for the period between 1996 and 2000 (bright red colour).

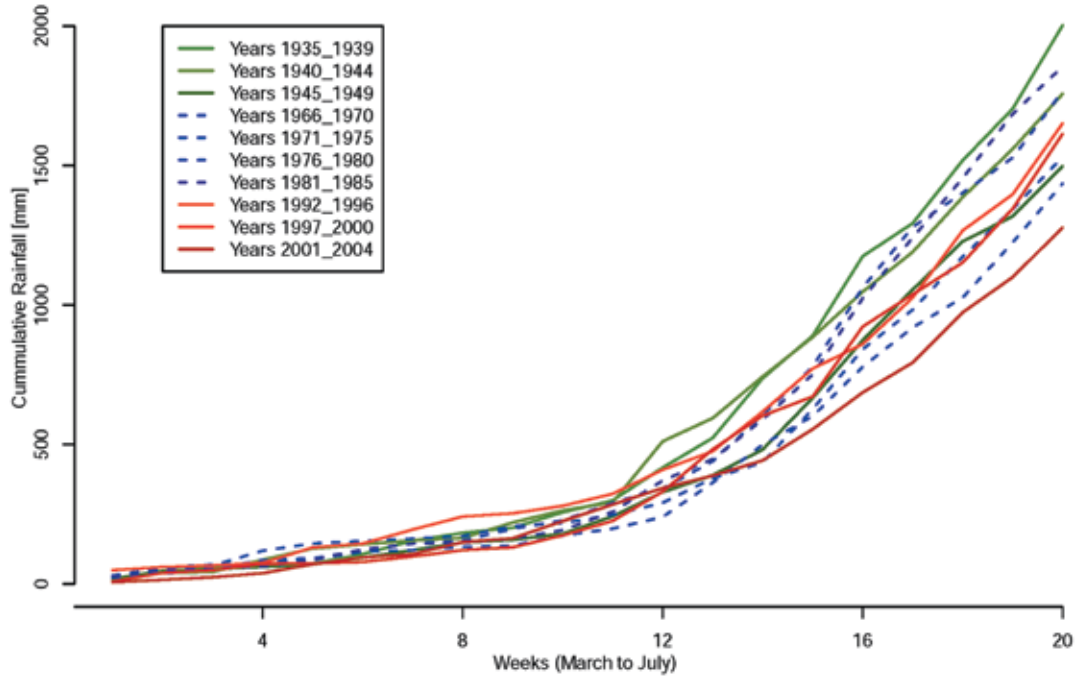


Figure 4.9. Toledo District – Cumulative rainfall for period March–July, in 5-year increments (except for 1941–44). Note the delayed onset of the rainy season in Toledo region, especially for the period between 1996 and 2000 (bright red colour).

period 2001–2004. In addition, the extremely dry period between 1971–1975 (especially the years 1973 and 1975; see Figures 4.6 and 4.8) corresponds well with the severe drought in 1973 reported in all four villages in the Cayo District (and 1975 in one of them). The relatively low rainfall and especially the late onset of the rainfall season in 1971–1975 period is also noticeable in the Toledo District (Figure 4.9).

In terms of inter-annual or seasonal variability of rainfall, Figure 4.10 (Toledo District) indicates a possible shift in the onset of the rainy season from April to May from the late 1960s to 1980s, although this is earlier than most people have suggested. From the 1990s onwards, there seems to be a high variability of rainfall during

[12] The only exceptions are the period 1941-1944, which uses a 4-year period, and the gap between 1944 and 1966, where the data are missing.

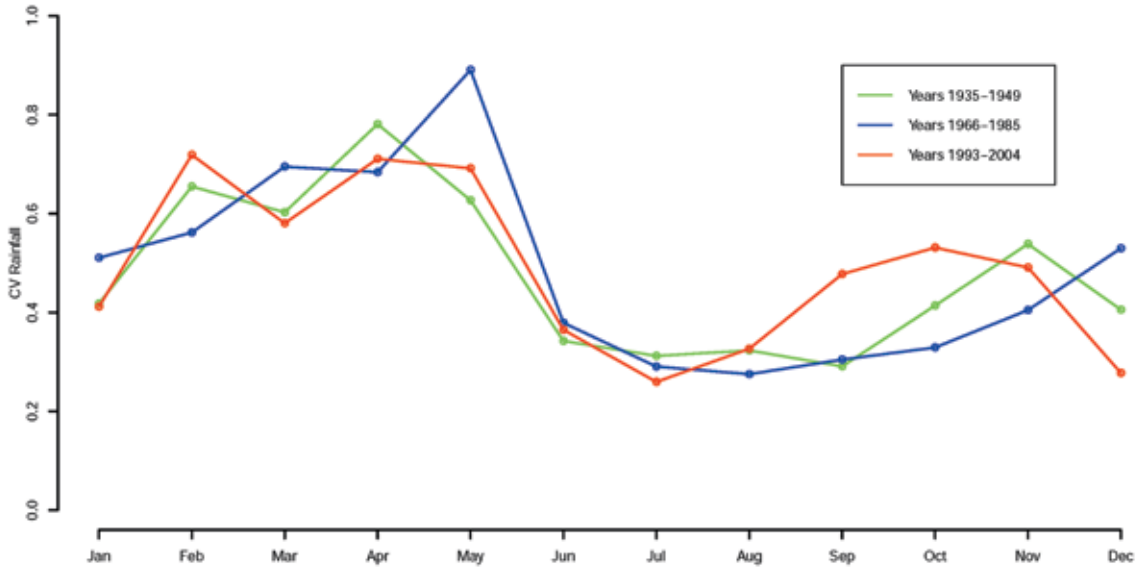


Figure 4.10. Toledo District – Seasonal variability of rainfall. Note a possible shift in the onset of the rainy season from April to May from the late 1960s to 1980s.

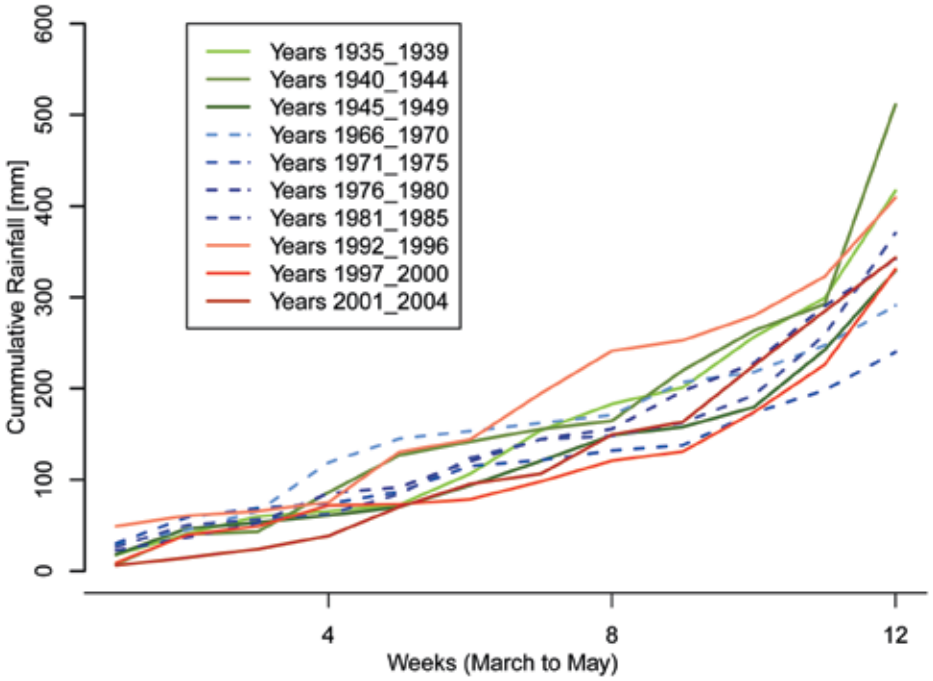


Figure 4.11. Toledo District – Cumulative rainfall for the period of March to May, in 5-year increments (except for 1941–44). See text for interpretation.

both April and May. This result might suggest that in the Toledo District, in this latest time period from 1990s onwards, the onset of the rainy season was unpredictable, sometimes starting early and at other times late. This is supported by Figure 4.11, which shows considerable differences between rainfall levels in the early months of the rainy season (April–May) between the 1992 and 2004 periods, with 1992–1996 being very wet, while 2001–2004 shows a delayed onset of the rainy season and 1997–2000 being one of the driest periods. This corresponds, at least for the Toledo District, with the accounts of the unpredictability of the onset of the rainy season in the recent past.

Further noteworthy patterns in the Toledo District are high variability in precipitation in February, and a dramatic increase in variability in the September-November period from 1993 onwards (Figure 4.10). Interestingly, the February to March period corresponds with the time of burning and the September to November period with

the second planting season. *Yaxkin* or *Matahambre* used to be an 'optional' crop, which was only planted when the first planting failed. The advantage of *Matahambre* is that while such crops still need rainfall to grow, the *milpa* does not require burning, so the planting phase is less sensitive to precipitation. In the case of first planting, the farmers work hard to time the burning with the onset of the first rains so that, on the one hand, the vegetation burns properly (producing the fertilising ash) and, on the other hand, the weeds do not have time to establish before the corn is planted. In this respect, the high variability in rainfall in February from early 1990s might indicate further complications for farmers in terms of timing the burning.

4.7. Archival data

In addition to the rainfall data presented above, further corroboration of some of the events mentioned by interviewees comes from published historical reports and articles. For example, the severe prolonged drought in 1949 was reported in the British Honduras report of the Forest Trust (1949:6): 'The drought began in March and continued until September with scarcely any interruption.' The report states that due to this drought, the logging and *chicle* industries experienced severe losses. Because of the lack of flooding, logs could not be transported by river until January 1950, which resulted in damage to the logs from splitting. In the *chicle* industry, due to dry weather, no business could be arranged until October (normally the arrangements take place in July) and 'the drought prevented work from getting under way till December' (Forest Trust 1949: 1). Severe damage by fire was also reported: 'Fire protection was a nightmare … It was inevitable that fire damage would be serious during such a dry year. The rainfall at the Agricultural Central farm near Cayo was 19.5 inches up to the end of November instead of about 60 inches. Grass fires burned millions of pine seedlings from one to four years old on the Mountain Pine Ridge and devastated 200 square miles of limestone country between the main Cayo road and the Mountain Pine Ridge' (Forest Trust 1949: 3). Elsewhere, the report stated that nearly the whole of the Mountain Pine ridge was burnt and not even the fire lines, which were 100 feet wide, were able to stop spreading fire. The damage to farms and plantations was so serious that the government set up an enquiry committee under the chairmanship of the conservator to advise on what action should be taken. The committee held meetings throughout the colony in farming areas. The cost accumulated through the construction of new fire lines and protection measures taken in the Cayo District amounted to $2,123 (Belize dollars, Forest Trust 1949: 1).

Further problems were reported in plantation work. Mahogany seedlings did not germinate, except in the Toledo District. In Stann Creek, 30 per cent of the 100 acres of planted pine died and, of 96 acres planted with pine seedlings, only those planted before June survived; later plantings died because of the lack of water (Forest Trust 1949: 2). The report also mentioned that cattle were dying on the pastures along the Belize River because of the drought. In the Toledo District, an attempt to start sowing corn in May is mentioned, but it was postponed due to the dry weather and only continued in the middle of June. Mahogany sowing was not completed until the end of June and due to poor germination, the sowing had to be repeated in August (Forest Trust 1949: 8).

There is another report of the 1949 drought in *A History of Agriculture in the Colony of British Honduras* (Darcel 1954). In a paragraph discussing corn production during the 1990s, the report states: '[1949 a record drought year! Exports were from 1948 crop – and we then imported for food]' (Darcel 1954: 15). Loses due to drought were also apparent in a financial statement comparing the revenues and expenditures in the years between 1940 and 1949 (Forest Trust 1949: 19; Table 4.3).

Table 4.3. Financial statement comparing the revenues and expenditures in the years between 1940 and 1949

Year ended	Revenue	Expenditure	Surplus or deficit
31st December 1940	107,007.00	29,699.00	77,309
31st December 1941	127,137.00	31,484.00	95,653
31st December 1942	89,721.00	33,118.00	56,603
31st December 1943	103,788.03	33,710.00	70,078
31st December 1944	144,513,39	44,567.00	99,946
31st December 1945	146,223.08	43,225.15	102,998
31st December 1946	166,109.72	57,414.00	109,696
31st December 1947	264,619.30	66,506.36	198,113
31st December 1948	225,508.42	93,292.36	132,216
31st December 1949	70,873.86**	116,713.80*	45,840

* Includes expenditure under C.D. & W. Scheme D951
** Does not include export duty on forest produce or C.D & W. Grant.
(From British Honduras, Forest Trust 1949: 19)

There are also reports of severe drought in 1975. The drought and its consequences are, for example, mentioned in *The Development of the Financial System in Belize* (1970–1995; Vellos and Sosa 1996). The report states that: 'The second phase 1975–1976 was a period of stagnation as real GDP averaged negative 0.03%. Heavy rains resulting from hurricanes in the later part of 1974 compounded by a prolonged drought in 1975, affected most agricultural crops while high inflation in the country's major trading partners contributed to a reduction in the production of those goods requiring a high import content' (Vellos and Sosa 1996: 4). The severely diminished rainfall is also reported in the yearly governmental reports (Government of Belize, Abstract of Statistics 1977, Tables 44, 45).

Although quite speculative and therefore mentioned only very tentatively, the data on mortality and birth rates for the period between 1975 and 1976 (Abstract of Statistics 1977, 1980) might also provide tentative support of the existence of some problems during these years. The data show markedly higher mortality especially in 1976 in all Belize districts (Table 4.4), and also a lower number of live births in some regions (Table 4.5), including Cayo and Toledo districts (Abstract of Statistics 1977, Table 33 and 1980, Table 1.7). As it is possible that there might be a different reason for such pattern (e.g., epidemic?) this is only presented as an observation.

4.8. Understanding environmental stress: combining perceptions, responses and data

The ethno-historical fieldwork conducted in 2011 provides insight into extreme environmental events and the effects that these events can have on subsistence agriculture and on how people respond. The analysis of the historical meteorological records from both regions suggest that rainfall patterns have changed over the period of time that our respondents remember. A basic but important conclusion is that 'drought' is a real phenomenon, often with severe consequences for livelihoods in the tropics. Although no human deaths directly attributable to drought were reported, people

Table 4.4 Number of deaths in individual Belize districts 1965–1977

Year	Total	Belize	Corozal	Orange Walk	Stann Creek	Cayo	Toledo
1965	710	333	72	72	104	68	61
1966	776	340	113	91	76	95	61
1967	811	385	88	95	106	69	68
1968	714	323	69	93	105	52	62
1969	783	357	89	69	105	105	58
1970	813	360	102	81	116	82	72
1971	625	291	75	71	54	83	51
1972	662	333	63	75	51	60	80
1973	774	394	81	63	31	85	120
1974	728	375	38	80	72	88	75
1975	733	376	46	73	62	70	106
1976	**881**	**413**	**97**	**91**	**93**	**103**	**84**
1977	767	379	88	81	90	60	69

Table 4.5 Number of live births in individual Belize districts 1970–1980

Year	Total	Belize	Corozal	Orange Walk	Stann Creek	Cayo	Toledo
1970	4,455	1,561	617	805	511	637	324
1971	5,052	1,784	684	868	546	734	436
1972	4,912	1,826	673	753	451	716	493
1973	5,010	1,722	730	821	522	831	384
1974	5,039	1,817	686	765	497	840	434
1975	5,201	2,034	655	809	514	787	402
1976	5,340	2,012	690	915	496	821	406
1977	5,570	2,089	798	893	507	810	473
1978	5,384	1,907	801	859	469	872	476
1979	5,523	1,992	711	893	514	886	527
1980	5,603	1,893	787	596	519	925	583

remembered hunger due to failed crops and even fighting for food in extreme cases.

In addition, it is clear from the published reports that droughts, especially the prolonged ones, had severe economic and possibly even health-related consequences, sometimes countrywide. The occurrence and impact of droughts in the tropics often comes as a surprise to outsiders who are not familiar with tropical conditions. The fact that rainfall can be limited and its absence damaging in the tropics is often overlooked by non-tropical investigators who normally assume there is an abundance of water. The nature of the effects from a lack of rain at certain times, less rain in a given period, or delayed onset of rain is subsumed by investigators under a single concept of 'drought'. Yet, the perception of what constitutes drought is relative and highly dependent on local climate and moisture requirements.

These differences are clearly distinguishable in the two ethnographic case study areas. In the Toledo District, where precipitation is substantially higher, droughts mainly affected the relative growth of crops and could be described as agricultural droughts rather than hydrological ones that affect groundwater levels. People there remembered fewer details and often could not specify the dates of these events. On the other hand, in the drier Cayo District, severe hydrological droughts were clearly remembered for long periods of time in all four villages; people were much more specific in relating these events, including the years, the seasons and the effects the droughts had both on specific water sources, such as wells and rivers, but also on crops and general wellbeing. Nevertheless, despite the drought obviously being perceived as an important and potentially dangerous problem, the effects of droughts (both agricultural and hydrological), hurricanes and the locust swarms *(chapulines)* were often conflated in the narratives. This is not surprising because subtle differences in cause and effect would matter little to subsistence farmers whose fields have been destroyed.

Another important observation is the perception of 'long-term' change in weather patterns or what is defined as climate change. In our study, 'long term' represents any period between 30 and 80 years, based on the age of our interviewees and the limitations of human memory. Our informants in both regions agreed on a shift in the weather patterns towards hotter and drier conditions, and most importantly, they agreed that the timing of the rainy season became less predictable. Although the perception of weather and its changes, especially over long periods of time, can be very subjective and in the case of the past often idealised, many informants provided clear, specific examples (often in quantifiable terms, such as dates, water levels) to support their observations. At least some of the observed weather patterns are also supported by recorded rainfall data and the most severe prolonged droughts, such as in 1949 and 1975, were reported in numerous documents and articles. These observations, therefore, support the hypothesis that these changes indicate a major shift in climate.

How did these communities respond to environmentally induced stress? The most common response, which was shared by both areas, was to rely on their traditional knowledge: when agriculture became unreliable, they would rely more heavily on hunting and gathering activities. In some cases, diet breadth may have increased, but most likely their diet consisted of what was available at the time (e.g., ground food). Subsistence strategies in both regions were combined with wage-labour strategies, and in the Cayo District, with appeals for government aid (in Toledo, this was less of an option). To deal with the long-term change – the shift in the onset of the rainy season – an adjusted planting schedule was reported in both regions, although the onset variability made this difficult. In Cayo, different, faster-growing corn cultivars were planted and mechanised farming was adopted, though with mixed results.

An important point regarding the coping strategies that should be emphasised is that in some cases, the droughts themselves are only part of the problem and the increased vulnerability to social or economic exploitation is the most significant potential consequence. For example, although wage labour was frequently sought after in times of environmental stress, the economic arrangements usually involved in-kind payments of food and harvest-sharing and often seem to have been disadvantageous to people from the villages. Similarly, help offered by government to rural communities seemed designed to further government goals by increasing private land ownership in rural areas. Therefore, these moments of vulnerability can also exacerbate economic and political inequality and this may have long-term repercussions.

The research also revealed a wide variety of contemporary religious ceremonies in both regions related to environmental stress, and drought in particular. In fact, the gradual erosion of ritual knowledge (largely due to the Protestant conversion that began in the 1960s) and the perceived failure to perform critical ceremonies was cited by many as a reason for the deterioration in expected weather conditions. In the Toledo District, a large majority of the rituals are still based on traditional beliefs, involving Maya gods and spirits. These traditions continue, albeit only by a small number of families and individuals rather than whole communities as in the past. In the Cayo District, the traditions seemed first to syncretise with Catholic symbolism; offerings and prayers taking place in churches rather than *milpas*, and then according to our informants, these gradually disappeared altogether. It needs to be considered that some of the differences evident in the ritual practices from these two regions might stem from the different ethnic backgrounds and areas the inhabitants originally came from, and also the extent to which they have retained traditional practices. In addition, we note that since the original research was conducted in 2011, indigenous rights to communal lands have been upheld in several court rulings (see Medina 2014; MLA and TAA 2020) and that the cultural landscape has changed significantly throughout Belize. Nevertheless, considering

the differences between these two regions, it is interesting that people in both districts reported the 'bathing' ritual, the only one of the rain-calling ceremonies shared by both regions. In addition, this ritual also appears in Thompson's ethnographic research (1930: 53) in almost identical form, providing a link between the contemporary rain-calling rituals and those recorded by him in the 1920s (discussed in more detail in chapter 8).

This chapter provides a portrait of responses to significant environmental stresses in the Cayo and Toledo districts over the last hundred years. Some of the observed weather patterns are supported by recorded rainfall data and by archival records. Ethnographic, ethnohistoric and meteorological data were analysed, and our results indicate that factors related to climate change are involved, particularly with regard to the delayed onset of the rainy season in recent decades. The research also identified rituals related to drought and rain-calling rituals performed to mitigate the effects of drought. There can be little doubt that drought, hurricanes and insect swarms had negative effects on rural livelihoods, but the people we spoke to report a wide variety of strategies to cope with the events as well as ways to adjust to changes, which in the long run may prove to be adaptive. It is also clear that such weather events can be remembered for a long time, which helps with accumulation of traditional knowledge and development of long-term adaptation strategies.

So, how do these observations help us to explore the potential evidence of environmental stress and human adaptation in the past, particularly in the archaeological and epigraphic records?

Palaeoclimatic records, providing reconstructions of long-term rainfall patterns, offer an opportunity to identify periods with changes in rainfall patterns, especially diminished precipitation. Identified periods can then be explored in the archaeological and written records, in order to look for evidence of how people in the past attempted to cope with environmental stress, using strategies observed in the ethnographic fieldwork.

Looking at the archaeological record first, arguably many of the above-mentioned short-term coping strategies (e.g., increased breadth of diet, seeking wage labour or adjusted planting schedule) would not be visible in the portable material culture or landscape record, although change in diet and increased hunting might be observable in the human and faunal remains. Adaptation strategies to long-term changes in weather patterns could be reflected in changes in settlement organisation, in water management or in agricultural methods. Although during the interviews, some people stated that they would not move during the drought, it is important to bear in mind that the reported droughts lasted only a year at most, and that the entire interval occurred in the modern period during which both territory and people were under the authority first of the British colonial government and then of the independent country of Belize. People mostly argued that they would not move because the little money they had needed to be saved to buy food and seeds to replant. But what would happen if the dry conditions persisted for several years, or if no government aid were available? Would that force people to move eventually? The changes in occupation size and/or changes in settlement patterns through time could be one avenue to explore. Furthermore, even if we assume moving to a different area as one of the decisions of last resort (although this is unlikely given our understanding of prehistoric Maya mobility), we can look at some of the possible strategies people would use before moving. If water is scarce, we might expect that there would be efforts to collect and store it, which might be reflected in changes in water management and related changes in agricultural strategies. Although the relationship between changes in settlement patterns, subsistence and water management strategies and responses to environmental stress should not be presupposed as causal, such a hypothesis is worthy of exploration.

Moving to epigraphic records, from the interviews it became obvious that religious ceremonies and rituals play a significant role when coping with extreme events. As described above, a variety of contemporary religious ceremonies related to drought have survived in some areas until today. Increased ritual activity as a mechanism for dealing with environmental stress has been discussed in other ethnographic studies (as discussed in Chapter 3). Therefore, looking for ritual activities in the hieroglyphic record and assessing whether these activities are contemporaneous with environmental stress is an important avenue of research. In the case of the existence of such rituals, we can explore the temporal and spatial patterns of their occurrence, their frequency and compare their occurrence to other types of data from contemporaneous settlement, agriculture or water management data.

5

Palaeoclimatic Reconstructions

5.1. Introduction

In this chapter, we move back from memories of the near present into a deeper Maya past. However, direct precipitation measurements for the Maya area have only been recorded for little more than the last 100 years (obtainable, for example, from http://www.ncdc.noaa.gov and http://climexp.knmi.nl/). Colonial records and Maya books, such as the Book of Chilam Balam, extend back to about the 15th century (Folan and Hyde 1985; Craine and Reindorp 1979). Precipitation records from earlier periods, however, have to be reconstructed from various long-term proxy records. The first part of the chapter discusses different types of proxies and associated methodologies, and the second part presents a short summary of the palaeoclimatic records for the Maya area (and adjacent regions).

5.2. Long-term precipitation proxies

Most proxy data derived from the Maya area are based on carbon and oxygen isotope values or sulphur/gypsum content from lake sediment cores (e.g., Northern Yucatan Peninsula, Peten Lakes) and isotopic and other data from terrestrial cave sediments and stalagmites (e.g., Southern Belize, Central Peten, Northwestern Yucatan).

One common method to derive precipitation data is to compare the ratios of oxygen ($^{18}O/^{16}O$) in microfossils found in lake sediments. The isotopes are extracted from shells of organisms such as ostracods (Crustacea) and bivalves found in the sediments of hydrologically closed (endorheic) lakes (Covich and Stuiver 1974; Hodell et al. 1995, Leng et al. 2006). Ostracod valves and bivalve shells are formed from the calcium carbonate ($CaCO_3$) contained in the water. The oxygen isotopes ratio of ^{18}O to ^{16}O incorporated in the carbonate shell therefore reflects the $^{18}O/^{16}O$ ratio of the water. When water in the lake evaporates, water containing the lighter isotope of oxygen ^{16}O evaporates faster than water with the heavier oxygen isotope ^{18}O, causing an increase in the $^{18}O/^{16}O$ ratio (Yeager and Hodell 2008: 213). Assuming that water levels in the closed-basin lakes (where most water is lost to evaporation rather than seepage or overland outflow) depend on a precipitation to evaporation ratio, increased $^{18}O/^{16}O$ ratio indicates more evaporation than precipitation. Oxygen isotope ratios derived from the valves/shells found in different layers of lake sediments, therefore, should reflect changes in the precipitation/evaporation ratio (P/E) over time and thus can serve as a proxy for increased or decreased precipitation (Yeager and Hodell 2008: 213).

In regions without lakes, speleothems provide very precise palaeoclimatic data (often more robust than lake sediments data). Speleothems are cave formations (flowstones, stalactites or stalagmites) created by deposition and accumulation of precipitated CaCO3 (Hill and Forti 1997: 15). In environments with annual cycles of dry and rainy seasons, the layers in speleothems are deposited yearly, not unlike tree rings and, therefore, they can usually provide palaeoclimatic data with fine-scale temporal resolution (Webster 2000: 63–65), especially because of the precision offered through the uranium-thorium dating method. If radiocarbon (C14) dating is used, the accuracy of dating may be compromised by contamination of material in the speleothem by limestone (old carbon), deposited by water seeping from sediments above the cave, thus making the dates older than they are. This problem can be mitigated through sampling active speleothems, where the date of the deposition of the last layer is known (Railsbeck et al. 1994; Moyes 2006: 93). Rainfall data from speleothems can be derived from several different properties, such as thickness and colour of calcite layers, their luminescence, reflectance and isotopic values from the stalagmite's carbonate material. The thickness of bands is related to the amount of water flowing over the speleothem (Genty and Quinif 1996). Their colour is determined by the density and translucence of the calcite, with dense, dark layers representing periods of dry conditions with low or interrupted drip rates. In contrast, more porous, lighter layers are indicative of wetter periods, during which the speleothem formed under a constant flow of water, keeping it free of dust (Webster et al. 2007: 9). Luminescence is closely related with colour; it is produced by organic acids from overlying soils and vegetation growing above the cave (Shopov et al. 1994; Webster et al. 2007: 9) and, therefore, functioning as a proxy for moisture level (Baker et al. 1998; Webster et al. 2007: 9).

A recent development in palaeoclimatic proxies is the use of molecular biomarkers, which is being used in the Maya area. Organic molecules, in this case, the wax lipids formed on surfaces of leaves and other plant tissues, preserve well in lake sediments, ice cores and other depositional environments (Douglass et al. 2015a: 13–14; Eglinton and Eglinton 2008). Hydrogen isotope ratios derived from plant-wax (δDwax) provide information about past changes in the isotopic composition of precipitation and are, therefore, good indicators of terrestrial hydrological change (Schefuss et al. 2005; Tierney et al. 2008; Konecky et al. 2011; Lane et al. 2014, cited in Douglas et al. 2015a: 14).

Rainfall records derived from plant-wax proxies have two main advantages over other types of palaeoclimatic proxies that have been used in the Maya Lowlands (Douglas et al. 2015a: 15). First, they can provide climate records for Maya regions that cannot be covered by other proxies,

thus expanding the spatial coverage of palaeoclimatic data. Wax-plant molecules are present in sediments of almost any coastal/marine or lake environments where terrestrial materials are deposited, making them abundant and easily accessible. Furthermore, records derived from plant-wax are less influenced by changes in local hydrological conditions, which can affect δ18O values in lacustrine records and some speleothem records. This means that they can provide more direct comparisons of precipitation records between regions, informing us about spatial variability in climate change (Douglas et al. 2015a: 16). There are, however, some problems with this proxy. Studies where the plant-waxes were dated showed that they are usually hundreds or thousands of years older than the sediment deposits in which they are found, so the process of transport of the lipids from terrestrial environments to lake/ocean sediments is poorly understood (Eglinton and Eglinton 2008, Smittenberg et al. 2004; Mollenhauer and Eglinton 2007, Vonk et al., 2010; Galy and Eglinton 2011 cited in Douglas et al. 2015a: 15). Despite this 'pre-ageing', Douglas and his colleagues argue that, for example, the plant-wax record from the Lake Chichancanab fits well with other palaeoclimatic records derived both from Chichancanab and other sites in the vicinity (2015a: 15).

Pollen analyses are also often used in palaeoclimatic reconstructions, especially for earlier periods. They are less reliable for palaeoclimatic reconstruction for the Late Holocene period, because they reflect mainly human activities (Leyden et al. 1998; Leyden 2002; Wahl et al. 2006).

5.3. Palaeoclimate records – short summary

The majority of the palaeoclimate evidence (Table 5.1) comes from Northern Yucatan and Central Mexico (i.e.,

Table 5.1. Palaeoclimate records from the Maya area and other regions in Central and South America

Locality	Type of proxy	Dry period	Reference
Northern Lowlands			
Lake Chichancanab	Oxygen isotopes Hydrogen isotopes	AD 770–870, AD 920–1100 8th–11th century AD	Hodell et al. 2005a Douglas et al. 2012, 2014, 2015a
Punta Laguna	Oxygen isotopes	AD 585, AD 750–850 AD 910–990, AD 1391 AD 760–770 AD 830–890	Curtis et al. 1996 Hodell et al. 2007
Laguna X'caamal	Oxygen isotopes	15th century AD	Hodell et al. 2005b
Tzabnah Cave,	Oxygen isotopes	AD 501–518, AD 527–539, AD 658–668, AD 804–938	Medina-Elizalde et al. 2010
Southern Lowlands			
Lake Salpeten	Oxygen isotopes	AD 570, AD 760–810, after AD 890	Rosenmeier et al. 2002a, 2016
Laguna Yaloch	Calcium carbonate	AD 750–900	Wahl et al. 2013
Lago Puerto Arturo	Oxygen isotopes	AD 150–250, AD 700–850	Wahl et al. 2014; Douglas et al. 2016
Macal Chasm cave	Carbon isotopes Oxygen and carbon istotopes, luminiscence	AD 780–910 590–550BC, 190–110BC, AD 250–330, AD 750–900, AD 1050–1180 and AD 1530–1580	Webster et al. 2007 Akers et al. 2016
Yok Balum Cave	Oxygen isotopes	AD 200–300, AD 820–870, AD 1020–1100, AD 1530–1580	Kennett et al. 2012
Elsewhere			
Cariaco Basin, Venezuela	Titanium concentration	AD 760, 810, 860, 910	Haug et al. 2003
Lake Pátzcuaro, Central Mexico	Strontium/calcium ratios	AD 750, 850	Metcalfe et al. 1994; Metcalfe 1995
Zacapu Basin, Central Mexico	Diatom records	AD 850	Metcalfe et al. 1994; Metcalfe 1995
La Piscine de Yuriria, Central Mexico	Diatom records	AD 550–1100	Metcalfe et al. 1994;
Barranca de Amealco, Querétaro, Mexico	Tree ring record	AD 897–922, AD AD 1149–1167, AD 1514–1539	Stahle et al. 2011
Chilibrillo Cave, Isthmus of Panama	Oxygen isotopes	AD 900–1310	Lachniet et al. 2004

Lake Chichancanab, Lake Punta Laguna, the Chaac speleothem from Tecoh in Northern Yucatan, Lake Pátzcuaro, Lake Piscina de Yuriria, Lake Guanajuato, Lake Hoy a San Nicolas de Parangueo, and Zacapu Basin). The number of records from the southern lowlands has been increasing, however, with proxy data derived from lacustrine sediments (Lake Peten Itza, Lake Salpeten, Laguna Yaloch and Lago Puerto Arturo in Central Peten), cave sediments (Reflection Cave) and speleothems (Macal Chasm in the Vaca Plateau in Western Belize and Yok Balum in Southern Belize). Other listed evidence comes from outside of the Maya area, and although some researchers state that this evidence is relevant due to a shared weather system, this is debatable because of the localised variation in precipitation, even within a relatively small region such as Belize (see study by Medina-Elizalde 2010).

Based on the correlation analysis between the precipitation records from Tzabnah cave (the Chaac speleothem) and other places in México, Central and South America show a high correlation (Fig. 5.1), which, according to Medina-Elizalde et al. (2010), indicates that the record from Tzabnah cave is a good predictor of climate in the Yucatan Peninsula, including the Maya lowlands. Unlike other researchers (e.g., Haug et al. 2003; Yaeger and Hodell 2008; Kennett et al. 2012), Medina-Elizalde and colleagues suggest, however, that the South American records, such as Cariaco Basin, are not likely to be good predictors of climate in the Maya lowlands, as the correlation maps show only a weak correlation between total annual precipitation at the Cariaco Basin and annual precipitation over the Yucatan Peninsula (Medina-Elizalde et al. 2010: 258).

To summarise the records presented in the table above: many records indicate a wet period during the Preclassic period (~500 BC–AD 200), which was interrupted by droughts during the Late/Terminal Preclassic (AD 200–250). Wet and stable conditions (i.e., low interannual

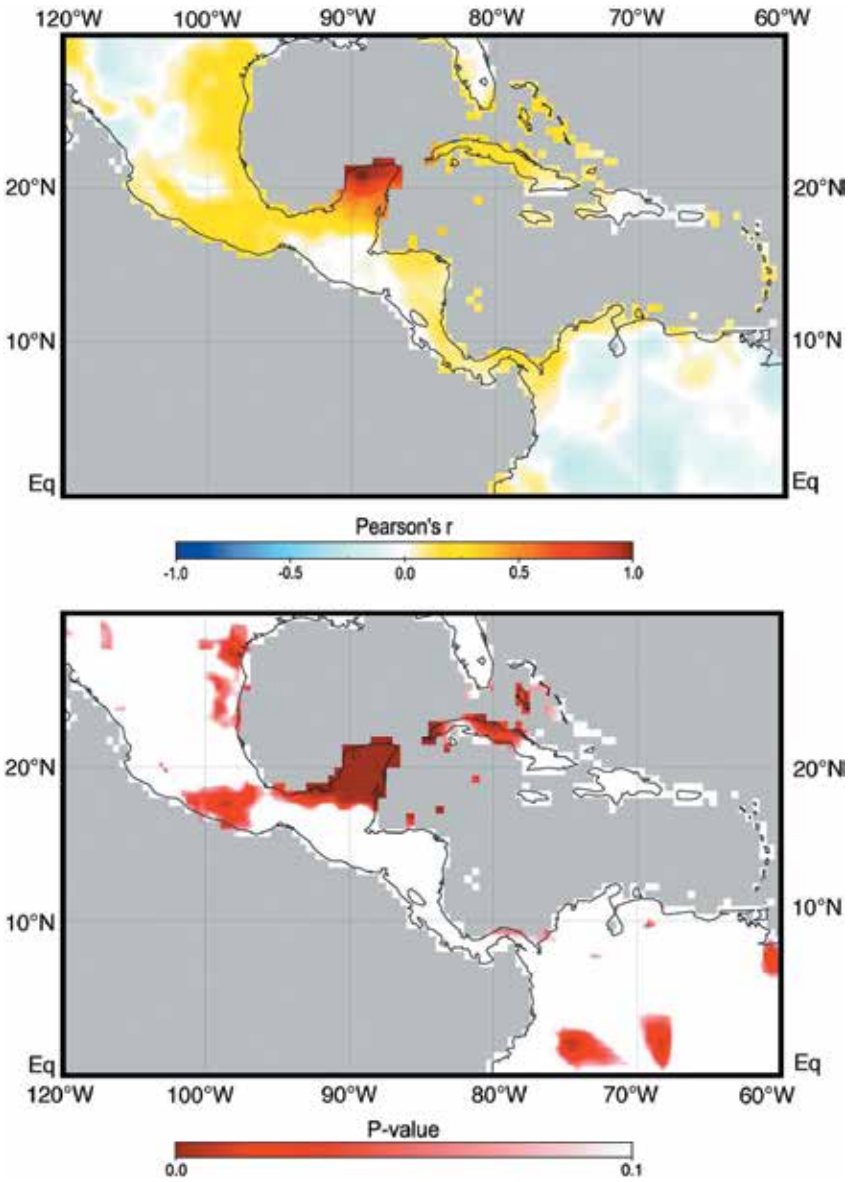


Figure 5.1. Correlation analysis among different regions in Mexico, Central and South America (reproduced with permission from Elsevier from Medina-Elizalde et al. 2010, Fig. 5).

variability) continued during the Classic period (with some exceptions in the Early Classic). Drier conditions then returned, with a number of severe droughts occurring during the Terminal Classic and Early Postclassic periods (between ~AD 750–1100) and a less severe dry period in the Little Ice Age around AD 1600. Although there are differences in the timing of the drought events, the evidence indicates that there were periods with prolonged and/or recurring droughts roughly contemporaneous and occurring at geographically distant areas. Many researchers perceive this as an evidence of a widespread climatic event (Metcalfe et al. 1994, 2010; Curtis 1996: 43, 1999; Gill 2000: 279; Horn and Sanford 1992: 354; Islebe and Hooghiemstra 1997: 600; Guenter 2014). On the other hand, with the increasing temporal resolution of these records, regional differences are emerging in the timing and intensity of droughts or periods with diminished precipitation.

As briefly discussed in Chapter 3, comparisons between the individual proxy records are not always straightforward. For instance, although a number of palaeoclimatic proxies are based on oxygen isotope values derived from sediment cores and speleothems from different regions of the Maya area, their variable temporal resolutions, problems with absolute dating (including correlating dates derived from different methods), and the influence that local hydrological conditions have on the isotope values make comparison between these records complicated (Rosenmeier et al. 2002a, b; Douglas et al. 2015a, 2016). Nevertheless, Douglas and colleagues (2015a, 2016) recently looked at the spatial variability in drought impacts in terms of both intensity and timing. Based on the comparison between the hydrogen isotope ratios of plant-wax lipids (∂D_{wax}) derived from the lake sediments of both Lake Chichancanab and Lake Salpeten, they argue that the dry period between AD 760 and 1100 was considerably more intense in the central Peten than in the northern part of the Yucatan Peninsula (2015b, 2016: 628). They also argue, based on the palaeoclimatic data synthesis (see Douglas et al. 2016: 622–623), that the timing of the onset of the dry intervals varies between the southern and northern lowlands, between individual regions and even sites. After the period of wetter conditions between ca. 500 BC to AD 200, records from both northern Yucatan Peninsula and the central lowlands show a shift to drier conditions by ca. AD 250, with two particular drought events recorded at ca. AD 250 and AD 500. The latter event seems to be more severe in the northern part of the peninsula and in the Lake Salpeten records, while the intensity of the earlier ca. AD 250 drought is expressed more strongly in the Macal Chasm, Puerto Arturo and Yok Balum records (Douglas et al. 2016: 625). Macal Chasm, Puerto Arturo and Lake Salpeten are all situated within ca. 100km from each other, which further stresses the high variability of rainfall patterns within the Maya area (observable in modern precipitation records), and therefore highlights the importance of regional records in palaeoclimatic reconstructions. However, some differences in the results could be due to the different methods and resolutions of the individual proxy records. There is another relatively wet period indicated in most of the records between ca. AD 600 and 730. However, for the northern Yucatan peninsula, this wet period extended until the end of the eighth century, perhaps reflecting the later onset of droughts associated with the 9th century AD in the northern area. The 9th to 11th century is linked with drought events 'unprecedented in terms of both frequency and intensity, for at least the preceding 1,800 years' (Douglas et al. 2016: 625). This time span, rather than consisting of one long dry period, includes two dry intervals: AD 770–950 and 1000–1100, and wetter periods between them. These, again, vary regionally. The earlier dry phase is shown to be comparatively mild in the Yok Balum record from Southern Belize. In contrast, the later dry period is less pronounced in the records from Lago Puerto Arturo in central lowlands and Chaac speleothem in the northern Yucatan Peninsula (Douglas et al. 2016: 625).

Given this spatial variability and highly variable rainfall patterns in particular, in Chapter 6 (where I compare palaeoclimatic data with occupation histories) and in Chapter 8 (where they are compared with epigraphic records), I use palaeoclimatic archives from areas that are as geographically close as possible, providing data are available (Fig. 5.2).

5.4. Quantitative estimates of droughts

Although the individual palaeoclimatic records provide relative estimates of the intensity of likely droughts in the past, especially in relation to each other through time, few studies offer quantitative estimates of their magnitude and only two of these are focused on the Terminal Classic droughts. As mentioned above, Medina-Elizalde et al. (2010) calculate quantitative estimates of rainfall variability during the Terminal Classic period by cross-correlating the Chaac speleothem $\delta^{18}O$ values with the instrumental rainfall record from the nearby city of Merida (1966–1994), by means of linear regression. They suggest that precipitation decreased by between 52% and 36% in comparison to the modern mean annual precipitation, making the droughts during the Terminal Classic period 'the most intense of the last 1500 years in the Yucatan Peninsula' (2010: 257). Furthermore, in a follow-up article, Medina-Elizalde and Rohling (2012) argue that this reduction in precipitation (~40%) might have been caused primarily by reduced tropical storm activity during the summer (rainy) season. These estimates were revisited recently by Douglas and colleagues (2016: 626–627). They argue that due to the large variability of the speleothem $\delta^{18}O$ values in comparison to the variability of $\delta^{18}O$ values in the modern rainfall data, which results in a high uncertainty in calibration, the error in annual rainfall during the Terminal Classic droughts (AD 800–950) is double than that used by Medina-Elizalde and colleagues. Douglas et al.(2016: 627) suggest that the precipitation during the Terminal Classic drought decreased by between 20–65% relative to today's mean annual precipitation. Either of these estimates would represent a significant

Figure 5.2. Location of palaeoclimatic records used in Chapters 6 and 8 for comparison with settlement and epigraphic data.

reduction of rainfall, especially in the northern Yucatan peninsula, where some regions receive barely enough rainfall to sustain maize agriculture under normal conditions. Moreover, if this reduction occurred during the rainy season, as suggested by Medina-Elizalde and Rohling, it would have had serious consequences for both agriculture and the general use of water, as discussed in Chapter 3 (Medina-Elizalde and Rohling 2012; Douglas et al. 2016).

5.5. Driving mechanisms of drought

Several different mechanisms have been proposed as causes of droughts in Maya area. The roughly simultaneous occurrence of periods with prolonged and/or reoccurring droughts at geographically distant areas has been seen by some researches as evidence of a single widespread climatic event (Metcalfe et al. 1994; Curtis 1996: 43, 1999; Gill 2000: 279; Horn and Sanford 1992: 354; Islebe and Hooghiemstra 1997: 600; Guenter 2014), and therefore linked to variability in solar activity (Hodell et al. 2001; Metcalfe et al. 2010). Metcalfe and colleagues argue that: 'This global forcing may be one reason why we can see regionally coherent responses over the long term, despite the lack of spatial coherency in the recent instrumental precipitation record' (2010: 1204).

Changes in circulation of the Pacific as well as the Atlantic Ocean (ENSO – El Niño/Southern Oscillation and NAO – North Atlantic Oscillation, respectively) have been linked to high spatial and seasonal variability in precipitation across the Yucatan Peninsula, with ENSO being the largest driving force of variability of clime in the tropics (Hastenrath 1978, 1984; Waylen et al. 1996; however see Hunt and Elliot 2005; Giannini et al. 2000, 2001; or Poveda et al. 2006). Increased frequency in ENSO events has been therefore seen as a possible cause of the late Holocene drying trend in the Maya lowlands (Wahl et al. 2014), although past ENSO frequency records do not seem to support this hypothesis (Douglas et al. 2016: 631). Frequency of ENSO has also been argued to affect the position of the Intertropical Convergence Zone (ITCZ) and in turn the amount of precipitation during the late Holocene in the Maya lowlands (Haug et al. 2001). The annual weather cycle in Yucatan is closely related to the shifts in the position of the Intertropical Convergence Zone (ITCZ) and to the North Atlantic subtropical high-pressure system (also called Azora-Bermuda high), in which the northward movement of the ITCZ and Azora-Bermuda high coincides with the rainy season, and their southward shift with the dry season and reduced rainfall (Hastenrath 1984, 1991; Gray 1993).

Another driving mechanism linked especially to 9th and 10th-century droughts on the Northern Yucatan peninsula are tropical cyclones and changes in their frequency and intensity (Medina-Elizalde and Rohling 2012). Other causes include changes in temperature gradients of the Atlantic and Pacific Oceans (Enfield & Alfaro 1999; Giannini et al. 2000; Taylor et al. 2002, 2011 cited in Douglas et al. 2016: 632) and deforestation (Oglesby et al. 2010; Cook et al. 2012). All these mechanisms have been proposed as possible causes, but so far there is no agreement among researchers about one particular driving mechanism and it is more likely that multiple factors were involved (Douglass et al. 2016: 628).

6

Settlement Patterns

6.1. Introduction

In this chapter, I examine the settlement history of the Belize Valley and Peten Lakes region and the northern Yucatan Peninsula. I explore the nature and chronology of settlement in each area and, in particular, changes in settlement patterns through time. My intent is to explore which factors might have influenced settlement, what patterns emerge over time and what their implications might be. Because environmental conditions, such as rainfall, have dominated the literature as causal factors in recent years, I focus on palaeoclimatic change and its effects on settlement patterns. I also consider socio-political factors, competition, warfare, centralisation-decentralisation of political and economic power, mobility, foreign influence and religious beliefs. The chapter starts with a discussion of the regional settlement histories of the case study regions, and then continues with analyses and interpretations of compiled settlement data on different scales of analysis.

6.2. Regional settlement histories through time

6.2.1. Belize Valley

The Belize Valley is primarily defined by the Belize River and its numerous tributaries (Fig. 6.1). Formed by the confluence of the Macal and Mopan Rivers, the Belize River runs east to west across central Belize, emptying into the Caribbean, north of present day Belize City. The Belize River basin is defined by drainage from the Maya Mountains and the Yalbac Hills. Located along the eastern edge of the central Maya lowlands, the geological and natural diversity of the Belize Valley distinguishes it from the Peten to the west and the Yucatan to the north. Major Maya centres in the Belize Valley include (W-E): Xunantunich, Actuncan, Buenavista del Cayo, Cahal Pech; Baking Pot, Lower Dover, Blackman Eddy, Camelote and Bacna. Minor centres (W-E) include Altavista, Yaxox, Esperanza, Bacab Na, Bedran, Spanish Lookout, Floral Park, Barton Ramie, Ontario, Warrie Head and Saturday Creek (Hoggarth 2012; Ebert et al. 2016; Driver and Garber 2004). In terms of archaeological investigations, the Belize Valley is one of the most intensively studied areas in the Maya lowlands (Chase and Chase 2004; Hoggarth 2012), with many settlements having benefited from both intensive survey and excavation (e.g., Barton Ramie, Baking Pot, Cahal Pech, Xunantunich, Buenavista del Cayo, Lower Dower).

The beginning of occupation of major centres in the Belize Valley dates to the Middle Preclassic period with the earliest occupation from around 1100 BC (Cahal Pech, Blackman Eddy, Awe 1992; Garber et al. 2004). Overall settlement during the Middle Preclassic and continuing into the Late Preclassic/Terminal Preclassic (sometimes called Protoclassic) period is relatively dense with five or six centres located along the river (Ashmore and Leventhal 1993; LeCount et al. 2002; Neff 2008: 11). Traditionally, the poorly understood Early Classic period in the Belize Valley has been depicted as one of depopulation in the area (Ford 1990), with the surviving population aggregating into a few remaining centres. Recent research suggests, however, that the Early Classic period was in fact one of the more dynamic periods in Belizean prehistory (Awe and Helmke 2005). More precisely, Awe and Helmke argue that settlement data for at least Cahal Pech, Baking Pot and Barton Ramie suggest a significant increase in population throughout the valley during the Early Classic, supported by increased construction activity in the Cahal Pech, Buena Vista and Pacbitun site cores (2005: 47). This period also saw the introduction of inscribed monuments and increased complexity in ritual activity (Awe and Helmke 2005: 50).

The increased activity and rapid growth continued during the Late Classic period, when most of the large centres in the Belize River Valley witnessed florescence. Although these sites are relatively small, with the population of the major centres during the Late Classic of up to circa 3000 people (e.g., Baking Pot and Barton Ramie, Hoggarth 2012: 44), they formed almost continuous settlement patterns along the Belize River (Willey et al. 1965). The occupation of most sites continued until the Late and Terminal Classic, with the exception of Baking Pot and Barton Ramie, which seem to have been occupied until the Middle-Late Postclassic period (600 BC–AD 1300) (Audet 2002; Audet and Awe 2005; Aimers 2002), although a hiatus in activity during the Early Postclassic (AD 900–1200) has been suggested based on the accelerator mass spectrometry (AMS) radiocarbon dating of human skeletons (n=12) from Baking Pot (Hoggarth et al. 2014).

The data from settlement surveys and excavations indicate that after the Classic period (ca. AD 850) occupation in the Belize Valley continued through the Terminal Classic-Early Postclassic period; however, it is clear that in the Postclassic, the density of population was considerably reduced and settlement more dispersed. With the exception of Tipu and Barton Ramie, site cores were abandoned by the end of the Early Postclassic (ca. AD 1050) and only Tipu survived until the Historic period (Graham 1991, 2011; Graham et al. 1989). Even Tipu, the core of which was still occupied during the Terminal Classic and Early Postclassic period (Aimers 2002: 165, 541), shows a drop in the number of structures

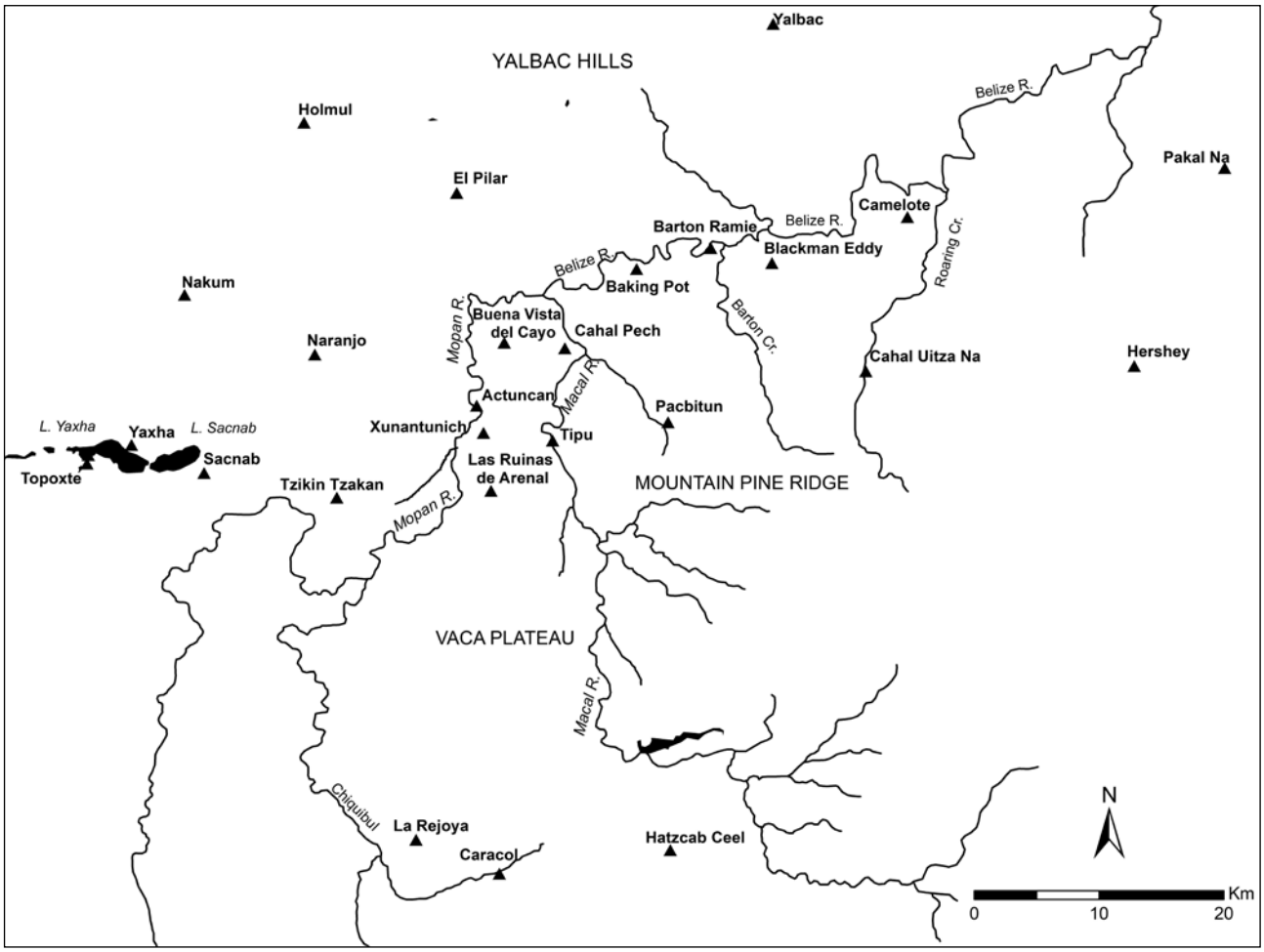


Figure 6.1. Eastern Central Lowlands including Belize Valley settlement.

and an 'almost random settlement pattern compared to the tightly clustered, orthogonal organisation of the Classic sites, and monumentality is lacking' (Aimers 2002: 163). During the Early Postclassic period in the Upper Belize River Valley, only Barton Ramie and Tipu, which have been suggested as cacao production places, formed nucleated village settlements (Aimers 2002: 166, 2007).

6.2.2. Peten Lakes region

Less than 100km to the west of the Belize Valley, in the Central Peten and especially in the Peten Lakes region, the situation is similar in many respects, but different in others. The area consists of a group of east-west trending lakes located along fault-line grabens, where the lakes developed (Dunning at al. 1998: 94) (Fig. 6. 2). The largest and deepest lake is Peten Itza, with two smaller lakes, Petenxil and Quexil to its south, and Lake Salpeten and Macanche immediately to the east. Further to the northeast lie Yaxha and Sacnab Lakes, close to Guatemala's border with Belize, and to the northwest are Sacpuy and Perdida Lakes.

Occupation in this area is concentrated on islands and peninsulas in these lakes, with sites such as Yaxha, Topoxte, Zacpeten and Tayasal. There are also several sites located on the northern shore of the Lake Peten Itza, which during the Late Clasic period belonged to the Motul de San José polity; the most prominent sites being the Motul de San José and Trinidad de Nosotros (Foias and Emery 2012).

While not directly in the lake basins area, but still close enough to be considered part of the Peten Lakes region, Tikal was the largest urban centre in the southern Maya lowlands. Located 30 km north of Lake Peten Itza, Tikal would have played important role in the political history of the region during its 2000 year-long history of occupation from the Middle Preclassic until the Early Postclassic (Culbert 2003).

Occupation in the Peten Lakes region begins in the Middle Preclassic period, with the earliest settlement dating to around 800–700 BC (Tikal, Motul de San José, Yaxha, Cerro Ortiz; Culbert 2003, Foias and Emery 2012, P. Rice 1986, Hermes 2000b, 2001). All of the lake basins continue to be occupied during the Early and Late Classic period. Quexil and Petenxil lake basins show only very sparse Early Classic occupation and were more densely occupied in the Late Classic. The settlement on Quexil Island, however, lasted until the Late Postclassic and partly into the Colonial Period (AD 800–1697). Although there is evidence for continuity of occupation in most lake

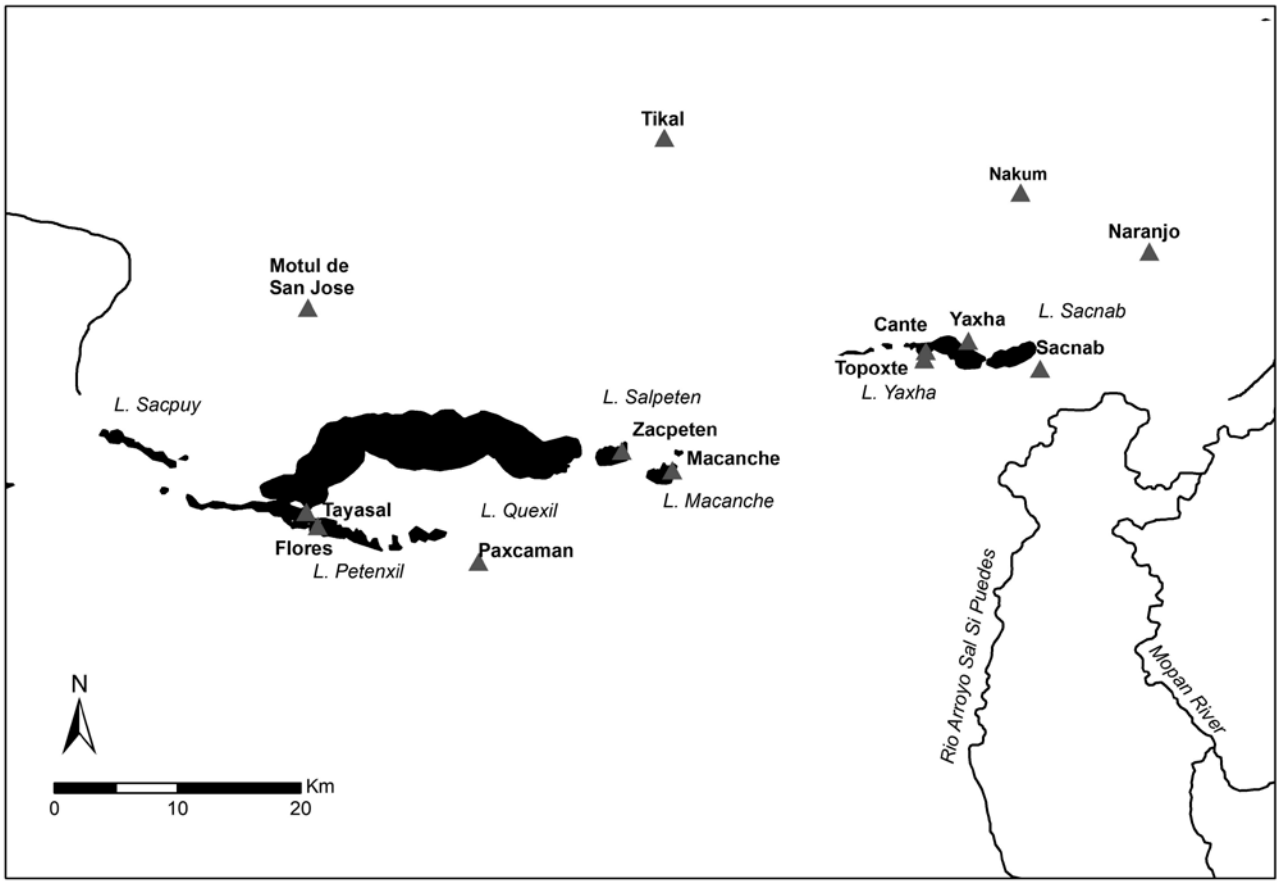


Figure 6.2. Peten Lakes region.

basins, many sites show diminished density of settlement after the Late Classic.

In addition, based on ceramic analysis, Prudence Rice (1986: 280–282) observed that there is lack of ceramic continuities between the Late and Terminal Classic, as is also evident at Barton Ramie. Peten Lakes Terminal Classic ceramic styles are very localised, reflecting the other broader changes observed in economic reorganisation, decentralisation of power and settlement.

Early and Late Postclassic occupation was detected at Macanche Island and marginally on the Macanche mainland (P. Rice 1986: 263). Further record of a dense Postclassic occupation comes from the site on the Lake Salpeten peninsula called Zacpeten (Fig. 6.3) and there is evidence of continuous occupation from the Late Classic until the Late Postclassic period. Again, there is only minor Postclassic settlement on the mainland of Lake Salpeten (P. Rice 1986: 264). Although Macanche and Zacpeten are close to each other, there seems to be difference in their material culture, pottery in particular (P. Rice 1986: 264). Further evidence of Postclassic occupation was found on Quexil and Petenxil Lakes. Quexil probably had some historical settlement as well as it has been equated with the 'Lake Eckixil' mentioned in Spanish documents (P. Rice 1986: 264). Similarly, 'Maconche' and Zacpeten, mentioned in the ethnohistorical record, can be related to archaeologically identified settlements around Lake Macanche (Rice and Rice 1981) and on Salpeten Lake peninsula, respectively (Rice and Rice 1984b).

Something of a unique phenomenon in the Peten Postclassic is the site of Topoxte, located on the island of Lake Yaxha (Fig. 6.4). The name Topoxte refers to three islands in the southwestern part of Lake Yaxha and it 'represents one of the major Postclassic settlements in the Southern Maya Lowlands' (Johnson 1985). Based on the Mayapan-affiliated architecture and polychrome ceramics, Bullard for the first time recognized the links of the Postclassic Peten to Yucatan (Bullard 1961, 1970). However, Robles (pers. comm. in Rice 1986: 293) argues that Topoxte is more closely related to sites of the east coast of the peninsula, and Prudence Rice suggests that the Postclassic florescence of the Topoxte Islands represents 'a local variant of a much broader Peten Postclassic tradition of island settlement and polychrome ceramic production' (1986: 292). In addition, Postclassic structures mapped on the Topoxte Islands allowed comparison between the spatial organisation of Classic and Postclassic settlements (Pugh 2003). It seems however, that the Postclassic florescence did not last long – according to the reports of Franciscans Fuensalida and Orbita, Topoxte Island was uninhabited by 1618 (Lopez de Cogolludo 1867–68: Book 9, 199–200).

On the northern shore of Peten Itza Lake, postclassic occupation was detected at Trinidad de Nosotros, one of the prominent sites of the Motul de San José polity (Foias

Figure 6.3. The site of Zacpeten on Lake Salpeten peninsula (from D. Rice 1986, Fig. 9.4).

2003, Foias ad Emery 2012). Although Motul de San José became a political capital during the Late Classic, it is Trinidad de Nosotros, located directly on the shore of the lake, that has the longer occupation history. Motul's influence began to wane during the Terminal Classic period and was practically abandoned during the Postclassic, while Trinidad se Nosotros expanded during this time (Foias and Emery 2012: 402). Furthermore, Trinidad may still have functioned as a port during the historical period (1500–1950) (Moriarty 2012: 226).

Another sizable Postclassic and colonial occupation was detected at Tayasal, a large Maya village located on a peninsula in Peten Itza Lake, directly across from Flores Island (Chase 1979, 1982, 1983a, 1985; Rice and Rice 1980, 1982; Pugh et al. 2012). Tayasal served as a refuge for people migrating from northern Yucatan, trying to escape Spanish authority and, as a 'core of resistance' most likely served as a centre of 'native solidarity' and cultural practices: the Itza were said to have continued to practise Precolumbian religious rituals despite the aggressive attempts to convert them to Catholicism (Rice 1986: 297; Jones 1983). The Peten continued to be occupied throughout the Spanish colonial period, until the late 17th century and, according to Jones (1998), the Itza played a major role in encouraging rebellions against Spanish authorities at Tipu and other settlements in Belize in the early and middle parts of the 17th century. They were, however, routed by Spanish troops in 1698 (Jones 1998).

Research shows continuity between the Classic and Postclassic cultures and occupation of the Peten, and contrary to previous beliefs that Postclassic occupation consisted mostly of people migrating from northern Yucatan, it suggests that Postclassic occupation resulted from a mixture of the development of indigenous communities and influences and migrations from the north (D. Rice 1976, 1986, 1988; P. Rice 1986, 1987, 2009; D. Rice and P. Rice 1980, 1981, 1982, 1984a, b, 1985, 1990, 2004, 2009; Andrews 1993: 42).

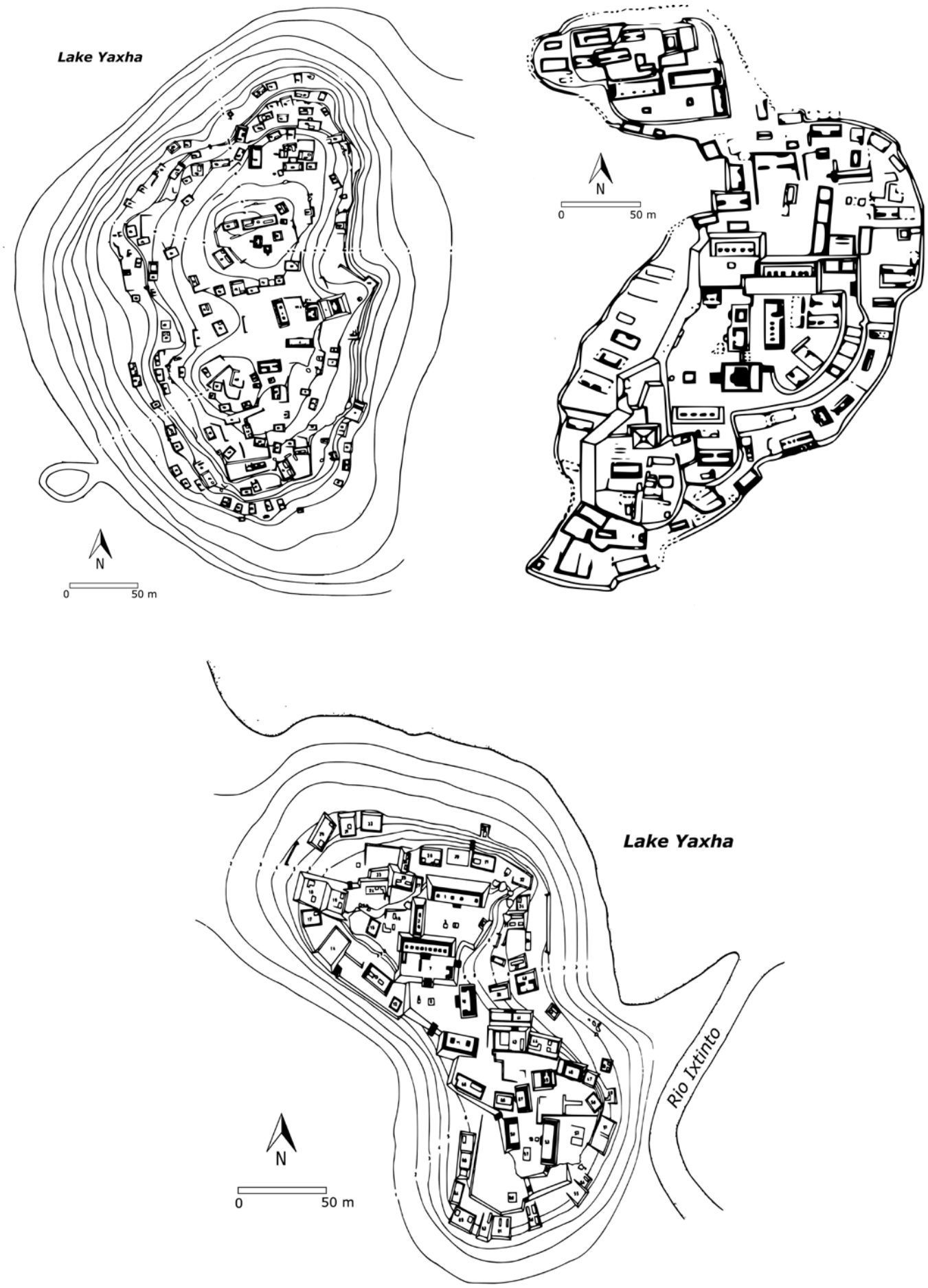


Figure 6.4. Topoxte Islands (Cante, Paxte and Topoxte), Peten (from Johnson 1985, Fig. 4).

6.2.3. Northern Yucatan Peninsula

The northern Maya lowlands were occupied from the late Middle Preclassic Period (1100/800 BC–400/300 BC) through the Late and Terminal Classic periods (ca. AD 1000) (Anderson 2003; Andrews and Robles Castellanos 2008). The occupation during the late Middle Preclassic and later during the Late Classic period seems to have been concentrated mainly in northwest Yucatan (Fig. 6.5). The Middle Preclassic occupation, rather than consisting of a few dispersed simple farming hamlets, is represented by a variety of settlements of differing levels of complexity. Settlements vary from small hamlets to large settlements with plazas and public architecture, such as temple pyramids, ball courts and *sacbes* (Andrews and Robles Castellanos 2004: 8; Peniche May 2010). In the northwest, sites with these monumental features include Xtobo, Xocaneh and Poxila, and in the central part, Yaxuna. They appear at approximately the same time as sites with large structures in the central lowlands (e.g., Calakmul, Nakbe, Braswell 2012: 8).

Given the relatively sudden appearance of dense occupation in the northwest (so far the earliest evidence of occupation dates to 1000/800 BC, although it has been suggested that the lack of earlier traces might simply be due to preservation issues, i.e., shallow soils) and the complexity of the culture and settlement hierarchy, it has been suggested that the northwest might have been occupied by people from elsewhere or that it resulted from the mixture of the local population with technologically and culturally more advanced outsiders (Andrews and Robles Castellanos 2008).

The level of political organisation of the Middle Preclassic communities is still a hotly-debated topic, as is the nature of the transition between the Middle Preclassic and Late Preclassic period (400/300 BC–AD 250/400). However, archaeological data show that at some point in the second half of the Late Preclassic period, many of the Middle Preclassic sites in the northwest Yucatan were abandoned as a result of still poorly understood political changes that took place in that region. Sites, such as Komchen or Tiho, became new power centres with populations concentrated around them (Anderson 2011).

In other areas, such as Puuc or the Yalahau region, population and settlement density increased and the Late Preclassic period is marked by the emergence of coastal sites, which were reportedly absent during the Middle Preclassic period (Anderson 2003: 61). During the poorly understood transition from the Late Preclassic to the Early Classic period (AD 250/400–600), several areas and sites underwent demographic loss. These include sites such as Dzibilchaltun and Komchen in the northwest, the Yalahau region in the northeast and Yaxuna in the centre (Andrews and Andrews 1980, Glover and Stanton 2010). However, the demographic decline during this period is not universal as there are large Early Classic centres, such as Acaneh, Ake, Uci, Izamal, Oxkintok and Coba known in this region (Braswell 2012: 13).

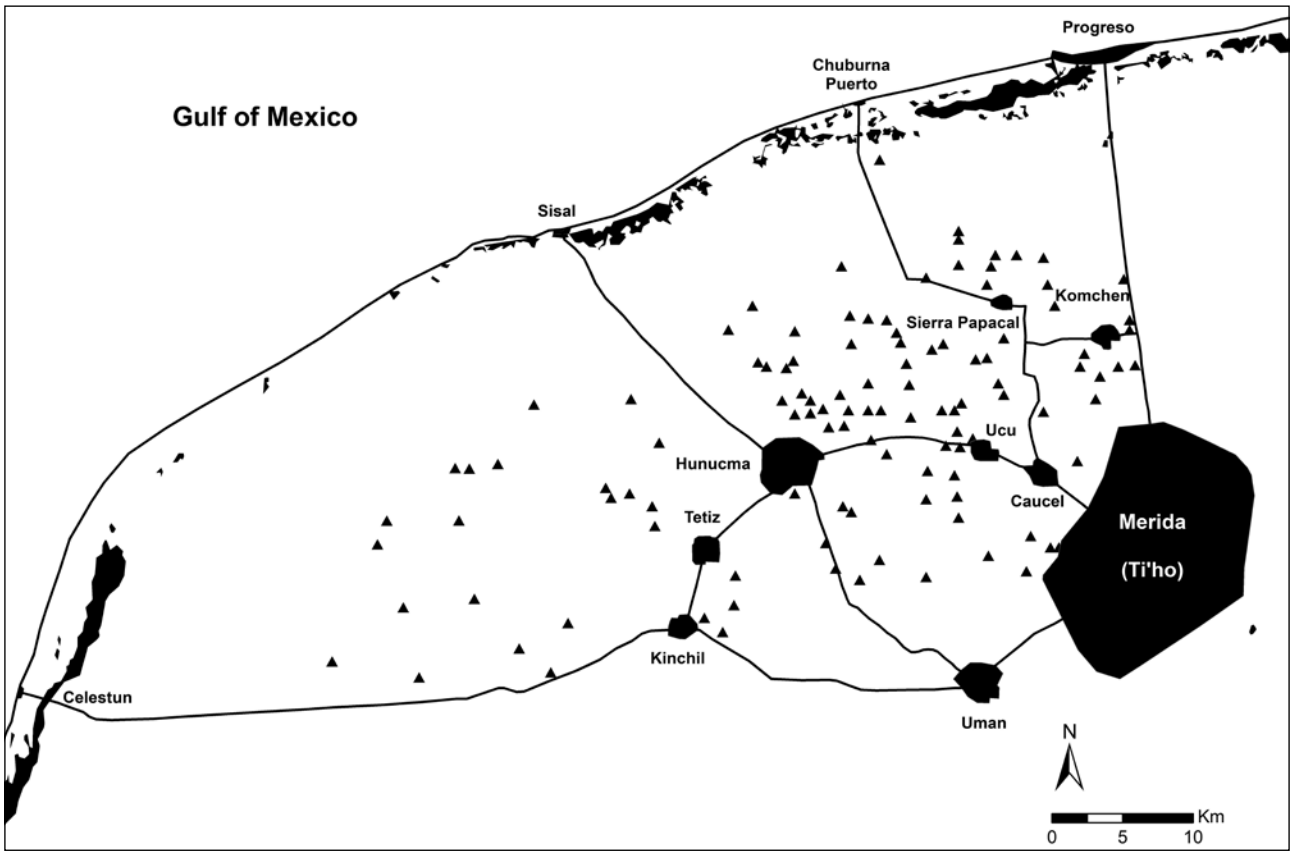


Figure 6.5. Settlement survey in the northwest Yucatan shows dense occupation from the Middle Preclassic period (1000/800 BC), redrawn from Andrews and Robles Castellanos 2003, Fig. 3.1.

The Early Classic period saw the increase of international trade and market economies, as shown by the excavation at Xcambo that revealed trade connections with Belize, Tabasco and coastal Campeche (Sierra Sossa 1999, 2001). Excavations at Chunchucmil, which was located in an especially infertile area, showed that the settlement had very high population density, and it has been suggested that it was an important market city supporting itself through trade (Dahlin et al. 2007; Hutson et al. 2006, 2010; Vis 2014). By the Late Early Classic there is an indication of weakening interaction between the southern/central and northern lowlands reflected by distinct ceramic manufacturing and decoration techniques (Varela Torrecilla and Braswell 2003).

During the Late Classic period (AD 600–780), population density in areas, such as the Puuc and northwest region, peaked. In fact, during this period, northwest Yucatan reached an occupation density not known anywhere else in the Maya lowlands (Braswell 2012: 16). Sites such as Dzibilchaltun or Sayil in the west and Coba and Ek Balam in the east thrived and grew to their greatest extent at this time. For example, between AD 600 and 800, Coba became one of the most important regional centres and the largest metropolis of the Maya world, covering territory of between 5000 and 8000 km^2 (Folan et al. 1983b: 213). Ek Balam served as a dynastic capital, designated by its emblem glyph, from the end of the Classic period until the early Terminal Classic. The eighth century also saw the emergence of the Puuc cities, marking the beginning of a new cultural renaissance in northern Yucatan, lasting more than a century after the southern polities started to decline (Andrews 1993: 54). The exception is the Cochuah region, which shows the lowest occupation density during the Late Classic period (AD 550–750), but reaches its occupational peak during the early phase of Terminal Classic (AD 750–900, Shaw 2010: 5).

The Terminal Classic (AD 780–1100), however, witnessed both the pinnacle of northern lowland Maya civilisation as well as its subsequent 'collapse'. In the Puuc region, Uxmal became a political capital and in the west central Yucatan, a new polity emerged at Chichen Itza which eventually became a large, powerful regional centre and one of the largest cities of Pre-Columbian Mesoamerica. Based on the archaeological and historical data, it seems likely that Chichen Itza gained, at the very least, economic and religious authority over most of northern Yucatan and commercially and militarily influenced the rest of Maya lowlands (Andrews 1993: 54, but see Braswell 2012: 20). Before the end of Terminal Classic, Chichen Itza is reported to have taken over Coba's trading networks, in particular, the Carribbean routes, said by some to have been controlled from the port of Xelha (Andrews and Robles Castellanos 1985: 69–71, but see Graham et al. 2017: 117–118 who argue for independent trade networks in Belize). Diminishing trade probably contributed to the downfall of Coba (and possibly Yaxuna, which depended on it), where there is little evidence of monumental construction after AD 1100 (Andrews and Robles Castellanos 1985: 71). After AD 1000, Coba's political influence was lost, but the centre most likely still carried symbolic and religious importance, which helped it to hold its status until AD 1000. Ek Balam showed demographic collapse and was nearly completely abandoned by AD 900 (Ringle et al. 2004). In the northwest, Dzibilchaltun became virtually abandoned by the beginning of the Early Postclassic period (Andrews and Andrews 1980). By the end of Terminal Classic, most cities across the peninsula were either abandoned or experienced significant drops in population level; occupation seems to have become concentrated in the coastal areas (Andrews and Sabloff 1986; Robles Castellanos and Andrews 2000). The only site that does not fall into this pattern is Chichen Itza which still flourished during the beginning of the Early Postclassic period (Braswell 2012: 20). By the end of the Early Postclassic (AD 1100–1200) and after the collapse of Chichen Itza there were few sites with significant occupation left in the inland region. One of the few exceptions, and certainly the largest inland site occupied during the Late Postclassic period (AD 1200–1540), is Mayapan. Due to the timing of its rise to power near the end of the Early Postclassic and the books of Chilam Balam mentioning attacks on Chichen Itza it has been suggested that Mayapan might have played a role in the final downfall of Chichen Itza (Hahn and Braswell 2012: 269).

There is an observable trend toward depopulation of inland sites, which began in the Terminal Classic and continued in the Late Postclassic period (AD 1200–1540). The coast was not abandoned however, and for the east coast of the Peninsula (Fig. 6.6), the Postclassic was a time of unprecedented growth, cultural renaissance, and population explosion (Andrews 1993). So far, more than 100 Late Postclassic sites have been recorded along the coast and on the islands of Quintana Roo. Coastal sites, with almost continuous settlement, controlled long-distance trade in the Late Postclassic. They were no longer dominated by Chichen Itza as is indicated by their substantial size and monumental architecture (Andrews 1993). Large sites, such as Paamul, Chakalal, Akumal, Xelha, Tancah and Tulum, are all located next to natural harbours. In addition, the Postclassic and Early Colonial ports of Xamanha (Playa del Carmen) and Pole (Xcaret) were important points of embarkation for Cozumel (Robles Castellanos and Andrews 1986: 63). They most likely served as trading ports and religious sanctuaries for pilgrims on the way to the shrine of Ixchel on Cozumel. In the case of Pole, the function of religious sanctuary or even a ceremonial centre is supported by the predominance of religious structures at the core of the site. Together with Tancah, Pole, whose occupational history also dates back to the Late Preclassic period, is one of few coastal sites occupied before the Late Postclassic period (Robles Castellanos and Andrews 1986: 63–69; Miller 1985: 32).

A similar role was probably played by Tulum, one of the major sites on the east coast, located on a cliff overlooking the sea about five kilometres south of Tancah. Apart from being a commercial exchange centre, Tulum had a significant religious influence on the region (Miller 1974;

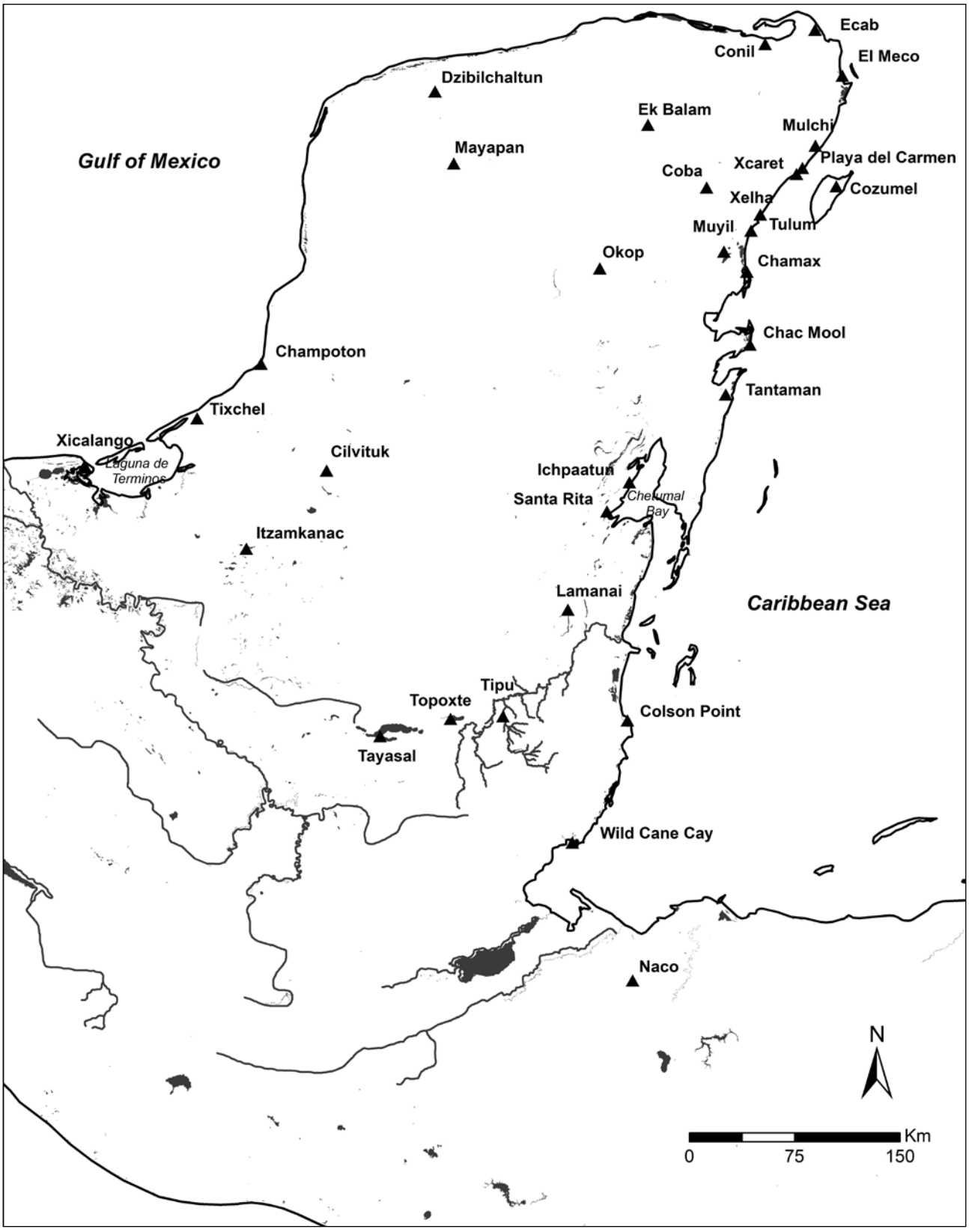


Figure 6.6. Late Postclassic Maya archaeological sites.

Sanders 1960). It was founded relatively late in the Early Postclassic, between AD 1100 and 1200, emerging (based on ceramic evidence) simultaneously with Mayapan and reaching its apogee during the Late Postclassic (Miller 1974). Tulum's history is linked with the site of Tancah, the history of which, however, dates back to at least the Late Preclassic period with continuous occupation during the Early and Late Classic periods (Miller 1985: 32; Sanders 1960). Tancah is a small site, located five km north of Tulum and its Classic period occupation has been estimated to have been a few hundred people within an area of 20 hectares (Sanders 1960). After short dominance over

Tancah (after AD 1400), Tulum was abandoned after 1521 and Tancah became the colonial site of Tzama, occupied until AD 1668 (Miller and Farriss 1979; Miller 1982).

6.3. Changes in settlement patterns

I will now explore the chronology and nature of settlement changes in the case study regions. I will evaluate if and how the evidence supports the hypotheses of what drove these changes. The examination is divided into three sections, reflecting three different scales of analysis:

(a) Regional changes in occupation and settlement patterns through time:
- How do occupation and settlement vary in different time periods across the case study regions?
- Is it possible to distinguish among the drivers behind these changes? For example, which regions were occupied early or late, and in what types of environments? How do the occupational changes relate to palaeoclimatic data and known socio-political changes?

(b) Local, inter- and intra-site changes in occupation through the time:
- How did occupation distribution change through time in the individual sites within the case study regions?
- Is it possible to distinguish between the drivers behind these changes? Within the same region, were some sites occupied longer than others? Could longer occupation reflect environmental conditions or be affected by socio-political factors?

(c) Intra-site settlement pattern changes through time:
- Do settlement patterns show signs of nucleation or dispersal related to time periods? Can we detect other changes, such as more or less formal organisation of settlement or change in the settlement's orientation? Is it possible to distinguish the drivers behind these changes? For example, increased/decreased centralisation or institutionalisation of Maya society, a move to defensible positions, or settlement changes reflecting religious beliefs?

6.3.1. Belize Valley and Peten Lakes

Examination of chronology, rate of occupation and change in settlement patterns through time is based on data from several survey and excavation projects conducted in the case study regions. Following on from the pioneering settlement survey project conducted by Gordon Willey and his colleagues in the Belize River Valley at the site of Barton Ramie in 1960s (Willey et al. 1965), several other projects have focused on settlement survey in the area. These include: the Belize River Archaeological Settlement Survey (BRASS; Ford 1990), the Xunantunich Settlement Survey (XSS; Ehret 1995; Neff et al. 1995), the Baking Pot settlement survey (Hoggarth 2012; Hoggarth et al. 2008; Jobbová 2009), plus survey and excavations at the sites of San Lorenzo (Yaeger 2000) and Actuncan (Mixter et al. 2014) in Xunantunich's hinterland (Fig. 6.7). Overall, approximately 26 km^2 has been surveyed and close to 2000 structures have been identified, with samples of between 10 and 20 per cent of structures having been excavated at each site.

Since the late 1970s, approximately 25 per cent of the Peten Lakes area has been surveyed by the Central Peten Historical Ecology project (Deevey 1978, 1984; Deevey et al. 1979; Rice and Rice 1980, 1981, 1984, 2004a; D. Rice 1986). The study region included the basins of Yaxha and Sacnab, Salpeten, Macanche, Petenxil and Quexil lakes (Fig. 6.7). A total of 1,879 structures were identified by the survey, and from these, about 25 per cent have been excavated by means of test-pits (D. Rice 1986: 302). Data from survey and excavation at the site of Nakum are also included in the analysis (Zrałka 2008, Table 7).

(a) Regional changes in settlement patterns and occupation through time:

While these individual projects have published observations on changes in settlement occupation, the publications consist mostly of simple counts of housemounds or structures occupied in different periods (except for Xunantunich area, see Yaeger 2010 and Mixter et al. 2014). The comparative data from the two regions have not, been presented in graph form until now (Fig. 6.8), nor have they been compared spatially in order to observe possible spatial patterns (Fig. 6.9).

(a) Regional settlement changes – Results

Both the Belize Valley and Peten Lakes (Fig. 6.8 a) were occupied from the Middle Preclassic, with an initial increase in occupation during the Late Preclassic period. There was a small decline in occupation during the Early Classic, which was more pronounced in the Peten Lakes region than in the Belize Valley. During the Late Classic period, both the Belize Valley and Peten Lakes regions experienced major growth and peaks in occupation, followed by a decline during the Terminal Classic. Looking more closely at the Peten Lakes occupation, comparing the mainland sites and sites located on islands and peninsulas (Fig. 6.8 b), there is an interesting trend. Whereas the mainland sites follow the same course of occupation as the Belize Valley, the sites located on islands and peninsulas show a slow, gradual increase in occupation from the Middle Preclassic period and an abrupt, significant increase in occupation during the Terminal Classic period. In the surveyed transects, the density of occupation at mainland sites decreased by 39.5% from the Terminal Classic to Early Postclassic times, whereas the island and peninsula sites show an 84.6% increase (D. Rice 1986: 327). The island and peninsula sites still show significant amount of occupation during the Early and especially Late Postclassic periods, when the majority of sites in both the Belize Valley and on the mainland around the Peten Lakes sites are nearly abandoned.

Directional analysis

In the Belize Valley, there is also a slight generalised trend in the occupation rate decreasing in a west-east direction

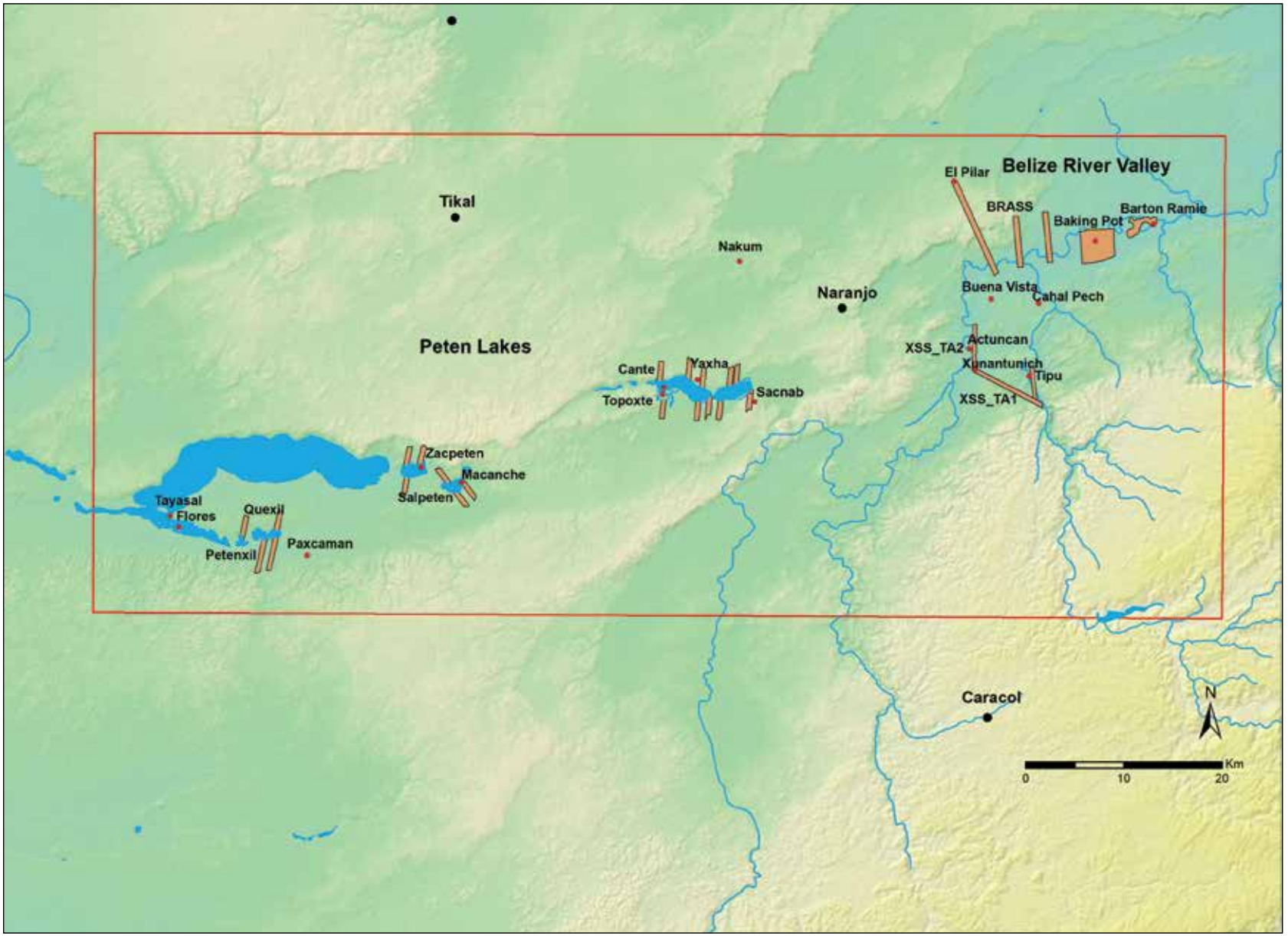
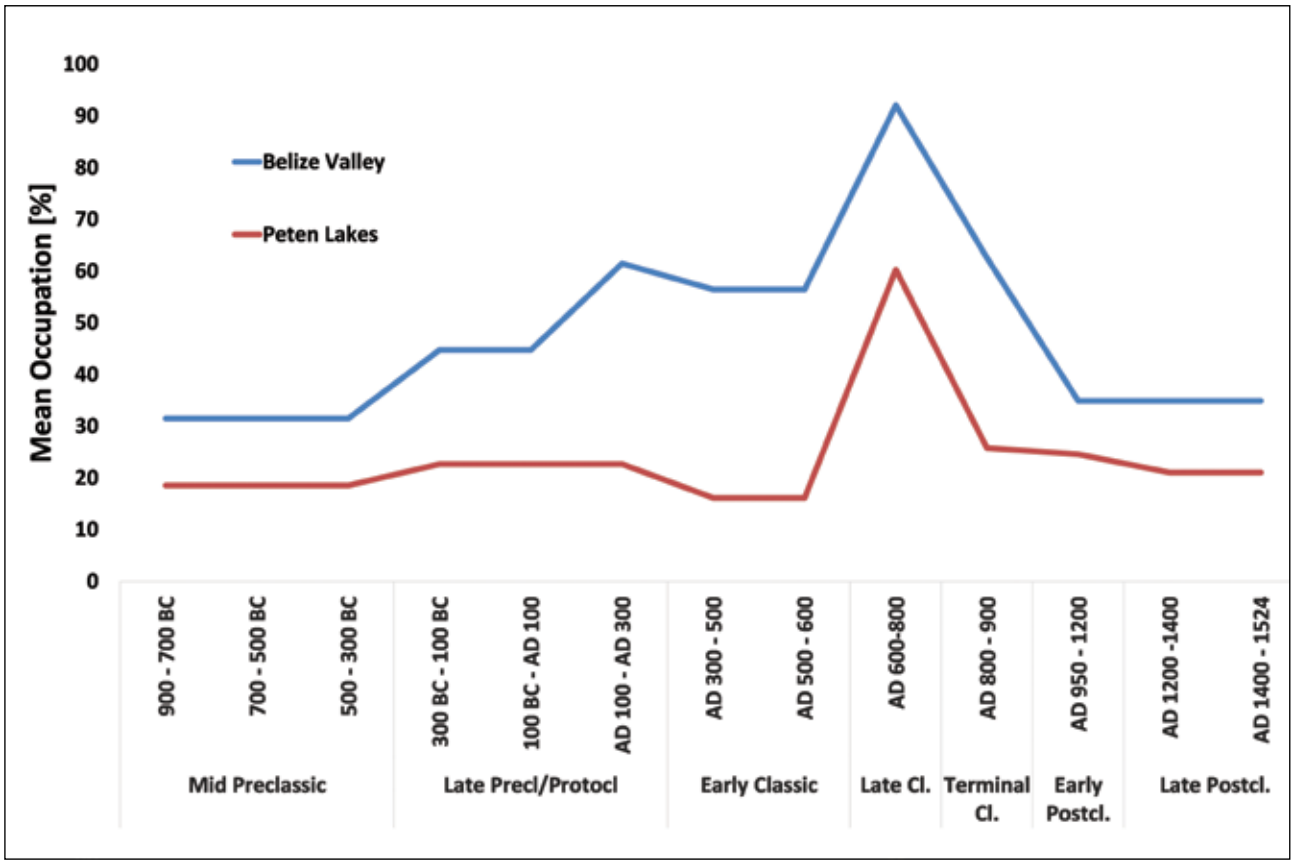
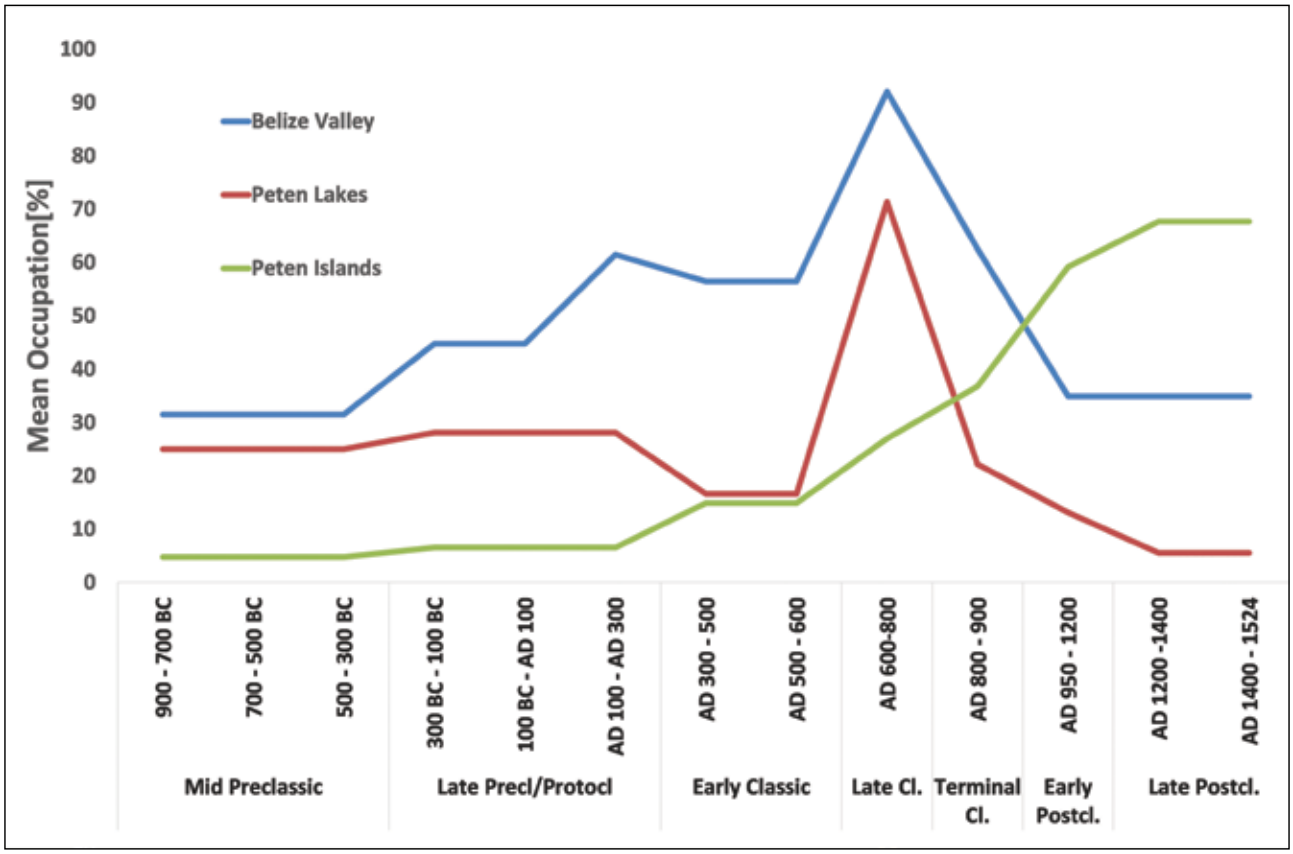


Figure 6.7. Areas covered by survey in Belize Valley (XSS_TA2, XSS_TA1, XSS_TA3 (Tipu), Baking Pot and Barton Ramie) and in Peten Lakes (Quexil- Petenxil, Macanche-Salpeten and Sacnab-Yaxha).



(a)



(b)

Figure 6.8. Occupation through the time in a) Belize Valley and Peten Lakes and b) Belize Valley and Peten Lakes divided to mainland and islands.

Table 6.1. Occupation distribution in areas covered by survey in Belize Valley (%)

Periods		XSS_TA1	XSS_TA2[13]	XSS_TA3 (Tipu)	BRASS	Baking Pot	Barton Ramie	Mean
Middle Preclassic	900–300 BC	21.00	44.07	100	51	22.02	27.69	44.30
Late Preclassic	300 BC–AD 150	12.00	30.51	67	91	54	36.9	48.57
Terminal Preclassic	AD 150–300	12.00	45.76	67	91	58.84	76.92	58.59
Early Classic	AD 300–600	30.00	35.59	67	49	77.98	76.9	56.08
Late Classic I	AD 600–670	58.00	55.93	67	98	93.9	84.62	76.24
Late Classic II	AD 670–780	79.00	76.27	100	98	100	100	92.21
Terminal Classic	AD 800–900	21.00	37.29	33	48	98.01	100	56.22
Postclassic	AD 900–1524	0.00	3.39	0	21	68.01	95.38	31.30

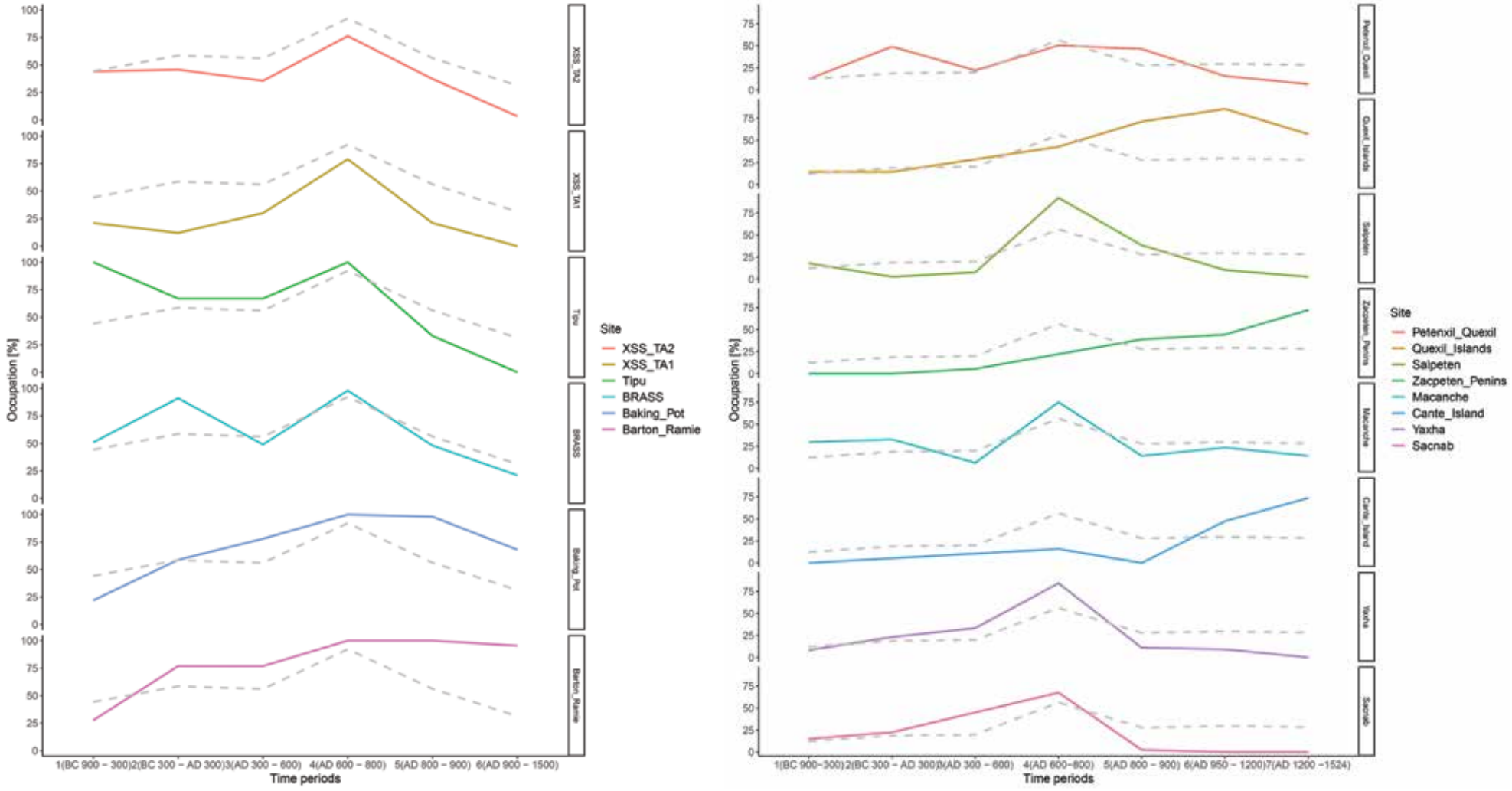
Table 6.2. Occupation distribution in areas covered by survey in Peten Lakes (%)

Periods		Petenxil-Quexil area[14]	Quexil Islands	Salpeten	Zacpeten Peninsula	Macanche area[15]	Yaxha	Sacnab	Mean
Middle Preclassic	900–300 BC	12.42	14.30	17.90	0.00	29.69	8.3	15	12.20
Late Preclassic	300 BC–AD 300	49.02	14.30	2.60	0.00	32.81	23.2	22.5	18.72
Early Classic	AD 300–600	22.22	28.57	7.69	5.56	6.25	33.33	45	19.89
Late Classic	AD 600–800	50.33	42.86	92.31	22.22	75.00	84.26	67.5	56.28
Terminal Classic	AD 800–950	46.41	71.43	38.46	38.89	14.06	11.11	2.5	27.86
Early Postclassic	AD 950–1200	15.69	85.71	10.26	44.40	23.44	9.26	0	29.52
Late Postclassic	AD 1200–1524	6.54	57.14	2.56	72.20	14.06	0	0	28.27

[13] XSS_TA2 includes San Lorenzo and Actuncan.

[14] Petenxil-Quexil lakes area includes Tayasal-Paxcaman.

[15] Macanche area includes sites Cerro Ortiz and Muralla de Leon.



(a) (b)

Figure 6.9. a) Directional west to east trend in occupation decline in Belize Valley, b) Reorganisation of Peten Lakes settlement and decline of occupation at mainland sites and an increase on islands and peninsulas (the dotted grey line in the charts represents mean occupation density).

(with sites in the west being abandoned earlier than those in the east) during the Late Classic and Postclassic period (Fig. 6.9a). In the Peten Lakes region, this directional pattern is not present. Instead, the movement to islands and peninsulas is observed again: a continuous trend of reorganisation of the settlement, starting in the Terminal Classic and continuing in the Early Postclassic, indicating a decline of occupation at mainland sites and an increase in the number of structures on islands and peninsulas (Fig. 6.9b). The only exception is the mainland settlement of Macanche, which shows an increase in occupation in the Early Postclassic period.

(b) Local, inter and intra-site changes in occupation through time:

The local variation in occupation in individual Belize River Valley sites or settlement survey areas is presented in Tables 6.3 a, b and visually represented in Figs. 6.10 a, b. The change in occupation in the Peten Lakes sites/survey areas is presented in Tables 6.4 a, b and visually represented in Figs. 6.11 a, b.

The occupation data presented in the tables and in graphical form involve both mound counts and percentages. The mound counts offer better comparison in terms of absolute changes in site occupation, while also expressing in graphic form the differences between the sites sizes. Percentages, on the other hand, better express relative changes in occupation.

(b) Inter and intra-site changes in occupation – Results

In the Belize Valley, broadly speaking, there are similarities in occupation trends at Baking Pot and Barton Ramie, and between Xunantunich, San Lorenzo and Actuncan (Fig. 6.10 a, b). Given their geographical proximity, this is not surprising, and in the case of San Lorenzo and Actuncan, these most likely belonged to the sphere of Xunantunich, at least during the Late Classic period when Xunantunich gained political dominance in the Upper Belize River Valley. Recent research in the area indicates that there was probably competition for the valley's resources and for political dominance between centres, such as Buenavista del Cayo and Xunantunich. Yaeger and others working in the area suggest that during the Hats' Chaak phase (AD 670–780 or Late Classic II), Xunantunich gained the upper hand and became the regional centre (Yaeger 2010; Connell 2010; Yaeger et al. 2012).

Figures 6.10 a, b show that Xunantunich was occupied from the Middle Preclassic period, with a small decline in occupation during the Late Preclassic and then a significant increase and peak in occupation during the Late Classic period. However, the period of florescence at Xunantunich did not last long and it was already declining during the Hats' Chaak phase; by the end of the Terminal Classic, the site was abandoned (Le Count and Yaeger 2010: 76–77). The occupational history of the Xunantunich hinterlands follows that of Xunantunich itself and is closely linked to the site's political standing (Yaeger 2010; see also Robin 1999, 2002, 2004; Neff 2010). The exception might have been the site of Actuncan, which shows continuing occupation and short-term revival, including construction activity, during the Terminal Classic period (Mixter et al. 2014). This revival was short lived, however, lasting only until sometime into the Postclassic period (Le Count et al. 2011). During the Postclassic period, the only sites showing occupation are Baking Pot and Barton Ramie, and Tipu located in the Macal River Valley (Aimers 2007; Graham 2011; Graham et al. 1985).

Figures 6.10 a, b show rapid and relatively steady growth of occupation from the Middle Preclassic until the Terminal Classic period (especially at Baking Pot, in comparison to the other sites, which show decline in occupation during the Early Classic period). As mentioned above, Barton Ramie and Baking Pot are occupied until well into the Postclassic period, long after the other sites in the Valley were abandoned or, at the very least, had substantially reduced populations.

In the Peten Lakes region (Fig. 6. 11 a, b), after the general peak in occupation during the Late Classic period and decline during the Terminal Classic, sites such as Cante Island, the Quexil Islands and the Zacpeten Peninsula show an increase in occupation during the Early and even the Late Postclassic period. In the case of Cante Island, although there are limited signs of occupation in the Preclassic and Classic periods, the site was abandoned in the Terminal Classic period, but then reoccupied and reached a peak in occupation during the Late Postclassic period. This phenomenon of Terminal Classic abandonment and later reoccupation was observed at Nakum and Copan as well (Zrałka 2008; Manahan and Canuto 2009). Another interesting occupation trend is shown for the Tayasal-Paxcaman zone, which could indicate possible competition between the Tayasal-Paxcaman area and the Yaxha-Sacnab basin (Fig. 6.11 a). While occupation decreased in the Tayasal-Paxcaman zone (along with the other sites in the region) during the Early Classic, there is a significant increase in occupation at the site of Yaxha and in the Sacnab basin (see also Hermes and Martínez 2005). Both Yaxha and Sacnab show continuing growth and peak in occupation during the Late Classic period and decline in occupation during the Terminal Classic in correspondence with all the other mainland settlements. With the decline of occupation at Yaxha (and other mainland sites), Tayasal-Paxcaman's occupation shows another increase during the Terminal Classic period, and then another cycle of decline and growth during the Early and Late Postclassic periods. Tayasal was still occupied during the Colonial period and it is believed to have been 'the last independent Maya kingdom of the Itza', conquered only by the Spaniards in AD 1697 (Chase and Chase 1986; Chase 1990: 149; Jones 1998). The Tayasal-Paxcaman zone shows a shift in construction and settlement pattern between the Early/

Table 6.3a. Occupation distribution across different periods in Belize Valley (housemound counts)

Periods		BRASS 5 km²	XSS[16] 5.9 km²	San Lorenzo	Actuncan[17]	Barton Ramie 2 km²	Baking Pot 9 km²
Middle Preclassic	900–300 BC	24	50	5	2	18	24
Late Preclassic	300 BC–AD 150	43	32	2	4	15//24	40//60
Terminal Preclassic	AD 150–300	–	40	5	7	50	65
Early Classic	AD 300–600	24	43	2	7	50	86
Late Classic I	AD 600–670	47	72	13	4	55	104
Late Classic II	AD 670–780	–	90	24	7	65	111
Terminal Classic	AD 800–900	23	22	10	6	65	109
Postclassic	AD 900–1524	10	0	0	2	62	75
Colonial	AD 1524–	0	0	0	0	0.00	0.00

Sources: Ford 1990: Table 8.2, Ehret 1995: Tables 1–13, Yaeger 2000: Table 4.4, Mixter et al. 2014: Table 1, Willey et al. 1965: p. 278–279, Hoggarth et al. 2008: Table 3–1.

Table 6.3b. Occupation distribution across different periods in Belize Valley (%)

Periods		BRASS	XSS	San Lorenzo	Actuncan*	Barton Ramie	Baking Pot
Middle Preclassic	900–300 BC	51	46.29	17	25	27.69	22.02
Late Preclassic	300 BC–AD 150	91	29.63	7	50	23.1//36.9	36.1//54
Terminal Preclassic	AD 150–300	91	37.03	17	88	76.92	58.84
Early Classic	AD 300–600	49	39.81	7	88	76.9	77.98
Late Classic I	AD 600–670	98	66.67	45	50	84.62	93.9
Late Classic II	AD 670–780	98	83.33	83	88	100	100
Terminal Classic	AD 800–900	48	20.37	34	75	100	98.01
Postclassic	AD 900–1524	21	0	0	25	95.38	68.01

[16] Xunantunich's data presented in Ehret 1995 were recalculated to reflect the number of housemounds instead of residential groups based on information in Table 1.
[17] Actuncan data are based on count of residential groups, instead of housemounds.

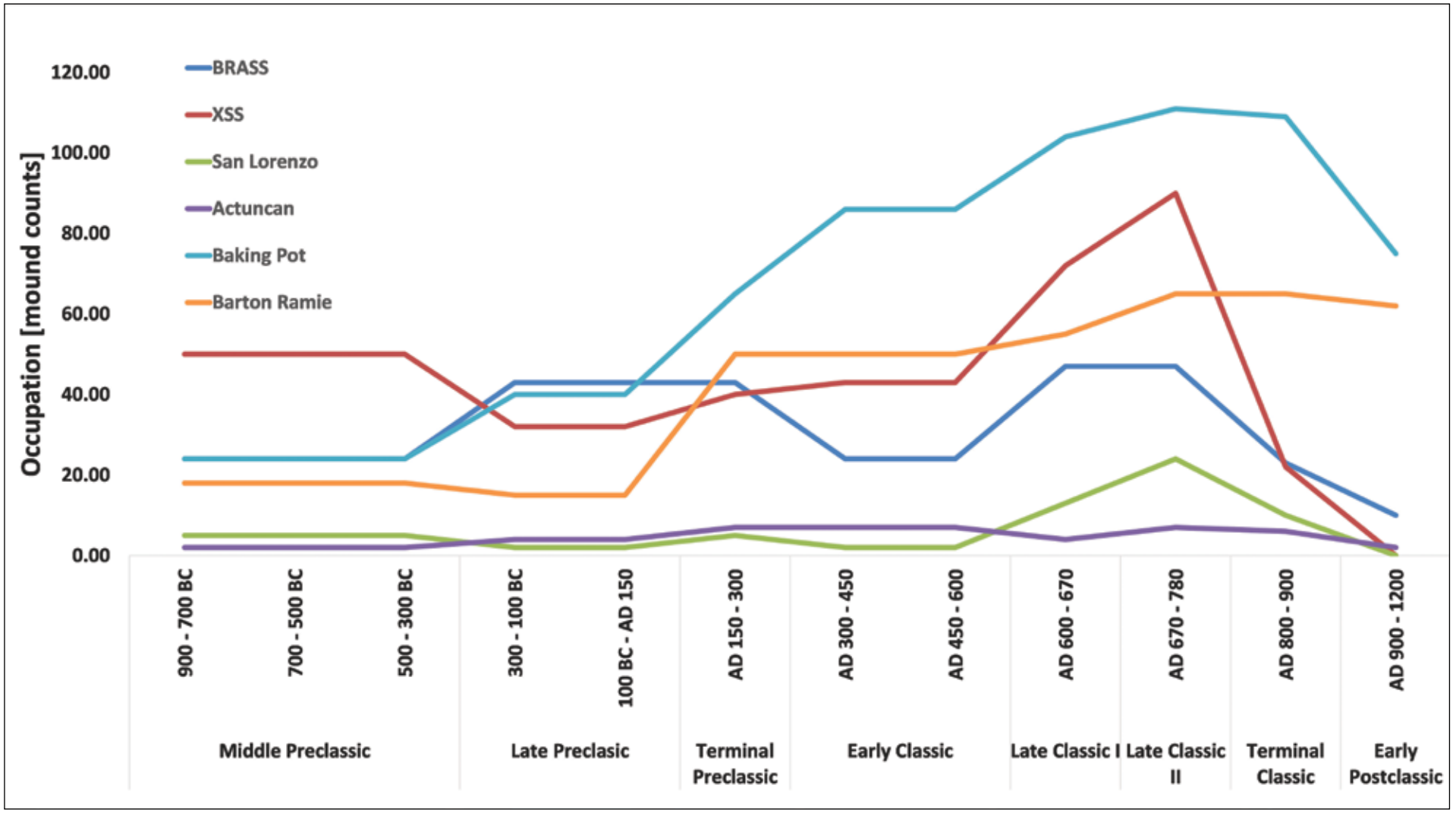


Figure 6.10. a) Occupation rates in Belize Valley sites during the different time periods based on mound counts.

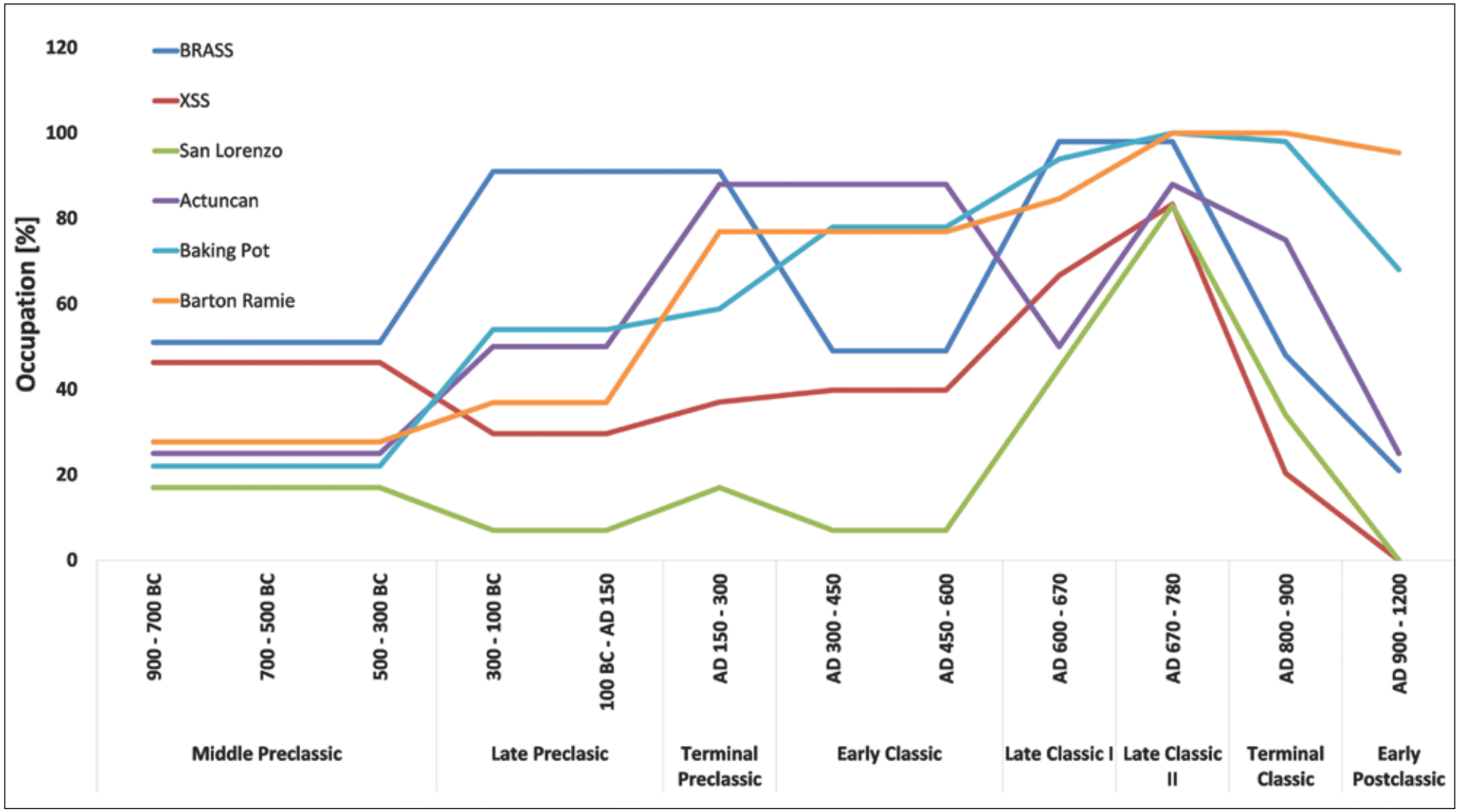


Figure 6.10. b) Occupation rates in Belize Valley sites during the different time periods based on percentages.

Table 6.4a. Occupation distribution across different periods in Peten Lakes area plus in Nakum (housemound counts)

Periods		Yaxha 6 km²	Cante Island 0.11 km²	Sacnab 4 km²	Macanche 3 km²	Salpeten 3 km²	Zacpeten Peninsula 0.23 km²	Quexil 4.5 km²	Petenxil 1 km²	Quexil Islands 0.036 km²	Tayasal-Paxcaman 5.12 km²	Muralla de Leon 0.13km²	Cerro Ortiz 1.7 km²	Nakum
Middle Preclassic	900–300 BC	9	0	6	12	7	0	14	0	1	5	0	7	6
Late Preclassic	300 BC–AD 300	25	1	9	13	1	0	4	0	1	71	6	2	26
Early Classic	AD 300– 600	36	2	18	3	3	1	1	1	2	27/32	0	1	6
Late Classic	AD 600–800	91	3	27	41	36	4	32	9	3	36	2	5	14
Terminal Classic	AD 800–950	12	0	1	7	15	7	5	3	5	63	0	2	31
Early Postclassic	AD 950–1200	10	9	0	11	4	8	1	0	6	23	2	2	0.00
Late Postclassic	AD 1200–1524	0	14	0	7	1	13	0	0	4	48/10	2	0	0.00

Table 6.4b. Occupation distribution across different periods in Peten Lakes area plus in Nakum (%)

Periods		Yaxha	Cante Island	Sacnab	Macanche	Salpeten	Zacpeten Peninsula	Quexil	Petenxil	Quexil Islands	Taysal-Paxcaman	Muralla de Leon	Cerro Ortiz	Nakum
Middle Preclassic	900–300 BC	8.3	0	15	22.6	17.9	0	40	0	14.3	4.59	0	100	17
Late Preclassic	300 BC–AD 300	23.2	5.3	22.5	24.5	2.6	0	11.4	0	14.3	65.14	75	28.6	72
Early Classic	AD 300–600	33.33	10.53	45	5.66	7.69	5.56	2.86	11.11	28.57	24.77/29.36	0	14.29	17
Late Classic	AD 600–800	84.26	15.79	67.5	77.36	92.31	22.22	91.43	100.00	42.86	33.03	25	71.43	39
Terminal Classic	AD 800–950	11.11	0.00	2.5	13.21	38.46	38.89	14.29	33.33	71.43	57.8	0	28.6	86
Early Postclassic	AD 950–1200	9.26	47.37	0	20.75	10.26	44.40	2.86	0.00	85.71	21.1	25	28.6	0.00
Late Postclassic	AD 1200–1524	0.00	73.68	0	13.21	2.56	72.20	0.00	0.00	57.14	44.04/9.17	25	0	0.00

Sources: D. Rice 1986: Table 9.1, Rice and Rice 1990, Table 6.2, Chase 1990: Table 7.2, Zrałka 2008: Table 7.

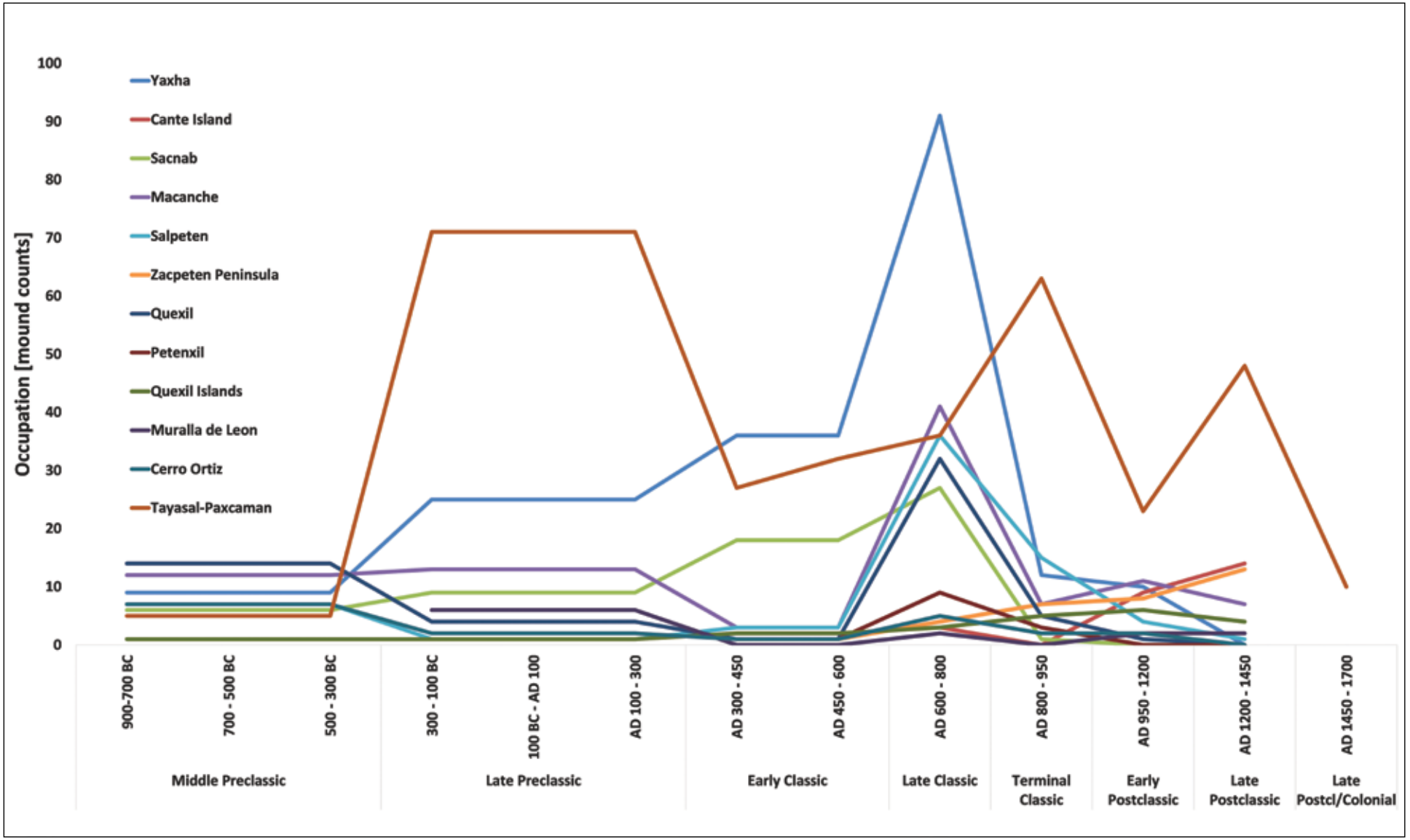


Figure 6. 11. a) Occupation rates in Peten Lakes sites during different time periods based on mound counts.

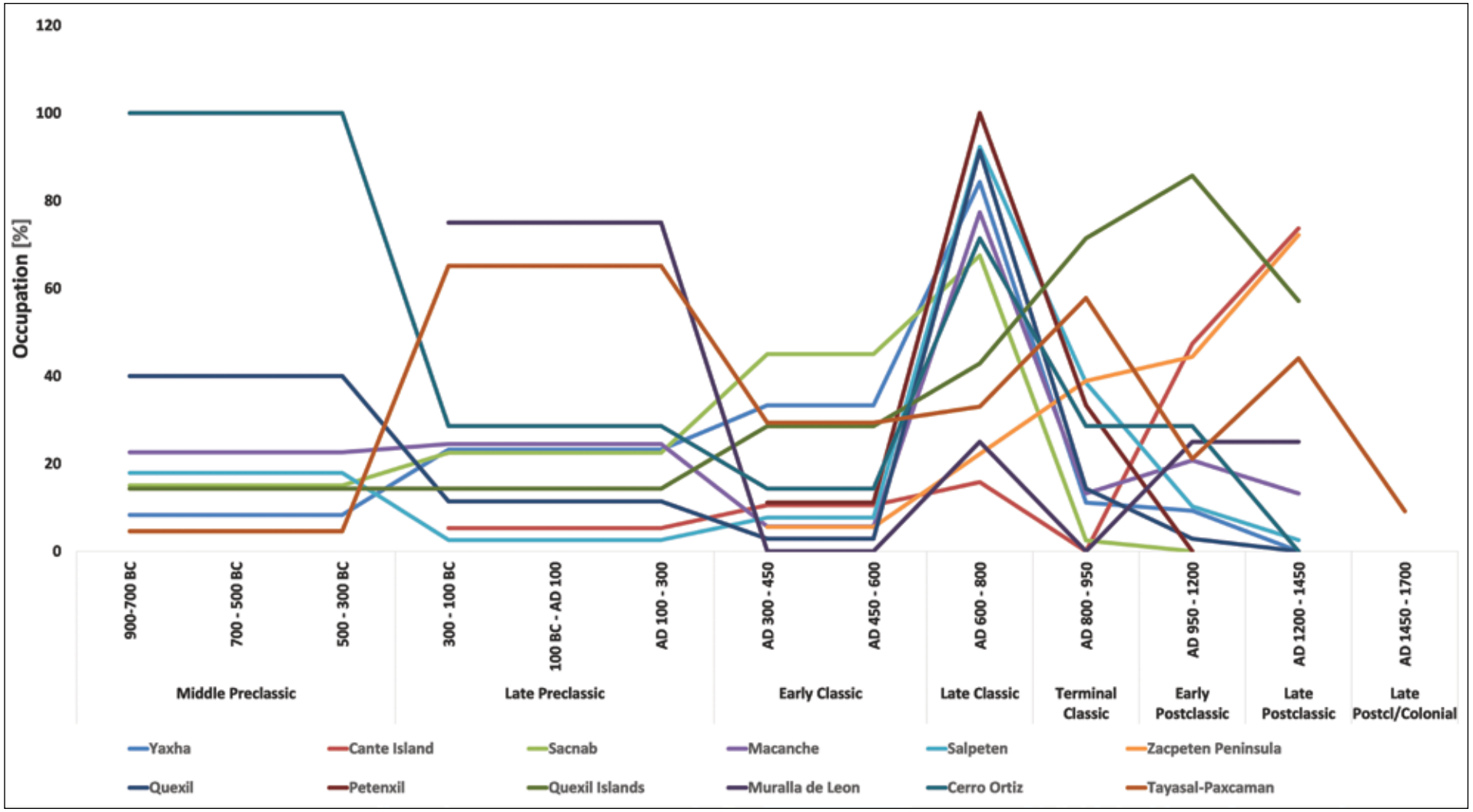


Figure 6.11. b) Occupation rates in Peten Lakes sites during different time periods based on percentages.

Late Classic and the Postclassic periods. The Early/Late Classic settlement was located on the peninsular ridge and characterised by the construction of large structures; this pattern gave way to small, 'often invisible house platforms' located near the lake Peten shores, during the later Postclassic period (A. Chase 1979, 1983a, 1985a, 1985b, 1990: 155–159). A similar case of competition and occupation shift seems to have occurred with Motul de San José and Trinidad de Nosotros (Emery and Foias 2012: 402). Motul de San José, located 3 km from the northern shore of the Peten Itza Lake, shows an initial occupation peak during the Late Preclassic period, followed by a decline during the Early Classic and another peak during the Late Classic, when it became the political capital of the Motul de San José polity. However, Motul's political influence and population density started to decline during the Terminal Classic period, and by the Postclassic it was more or less abandoned. On the contrary, Trinidad de Nosotros, located directly on the edge of the lake, shows growth during the Postclassic period, as do some other sites located closer to the lake (Emery and Foias 2012: 402).

(c) Intra-site settlement pattern changes through time and space:

To explore intra-site settlement changes (nucleation, dispersal and orientation), the site of Barton Ramie in the Belize River Valley and the sites in the Yaxha-Sacnab basins were used as case studies (based on data availability). Both areas were digitised and Figs. 6.12–6.15 represent changes in occupation, both in terms of structures that were constructed and occupied during individual time periods and in terms of the structures' spatial distribution.

(c) Nucleation, dispersal and orientation of settlement – Results

The settlement distribution at Barton Ramie over time indicates that the most obvious trend is considerable continuity in occupation (Fig. 6.12–6.15). The largest change in settlement distribution is perceivable in the transition between the Late Preclassic and Early Classic period, associated with the Mount Hope/Floral Park ceramic phase (100 BC–AD 300; sometimes referred to as the Protoclassic or Terminal Preclassic), when occupied housemounds increase considerably in number (by 77%) and expand over a broader area. After the Terminal Preclassic period, occupation continues to rise steadily until the Postclassic period. If we look specifically at the pattern in construction over time – that is, focus only on housemounds that show substantial construction – the situation is slightly different (Fig. 6.16a–g). There is very little construction activity indicated at Barton Ramie until the Protoclassic – Floral Park ceramic phase (AD/BC–AD 300), during which the construction increases considerably in accord with occupation levels. During the Early Classic-Hermitage phase (AD 300–600), construction activity seems to be maintained at the majority of houses constructed during the previous period, but there are very few newly built structures. Construction peaks during the Late Classic – Tiger Run phase (AD 600–700), when the highest number of houses are constructed, and during the Late Classic/Terminal Classic – Spanish Lookout phase (AD 700–900), when all except one of the excavated structures show construction activity. The situation changes in the Postclassic period – New Town Phase (AD 900–ca.1300), when 53 out of 62 occupied houses show construction activity and, according to Willey and colleagues (1965: 291), only 17 out of these showed 'substantial building'. As they further pointed out, it seems that Barton Ramie's inhabitants, during the New Town phase, were mainly living on the platforms built during the previous periods (Willey et al. 1965: 291). In addition, construction of all larger structures seems to have stopped. However, given the small number of large buildings at Barton Ramie, this is a very tentative observation, especially because the latest research has shown that Barton Ramie's administrative centre might have been located first at Blackman Eddy (Garber et al. 2004), and later, after Blackman Eddy was abandoned in the Late Classic, at the site of Lower Dower located south of the Belize River (Hoggarth 2012; Petroza 2015). There is no evidence of increased nucleation of the settlement over time; in fact, new structures seem to follow the directional and rectilinear patterns established during the previous periods (for more details on these patterns see Bevan et al. 2013).

Turning to the Yaxha-Sacnab basin, this region shows continuity of occupation from the Middle Preclassic until the Late Classic period, but not the rectilinearity, as structures seem to be distributed more randomly than at Barton Ramie. After the Late Classic period occupation peak, there is a significant drop in occupation (by 87% around Yaxha and 96% around Sacnab) in the Yaxha-Sacnab basin (Fig. 6.12–6.15). The only area still occupied was to the north of Lake Yaxha, close to the centre of the site of Yaxha. The largest change, however, is observable during the Postclassic period when, after a 'hiatus of unknown duration' (Rice and Rice 1980: 448), almost all the occupation was concentrated in the group of three small islands – the Topoxte Islands, located in the south-western part of Lake Yaxha (see also Hermes 2000b: 295, Gamez 2013: 206 and Wurster 2000). The occupation of the northern shore, according to Rice and Rice (1980: 447), is represented by only scattered Postclassic sherds; but no construction was identified, indicating that the earlier Classic platforms might have only been occasionally used in the Postclassic, with no new construction or intensive settlement.

Looking at the other locations of the Postclassic occupation, there is clearly a preference for physiographically delimited locations, such as islands and peninsulas (e.g., islands in Yaxha, Quexil, and

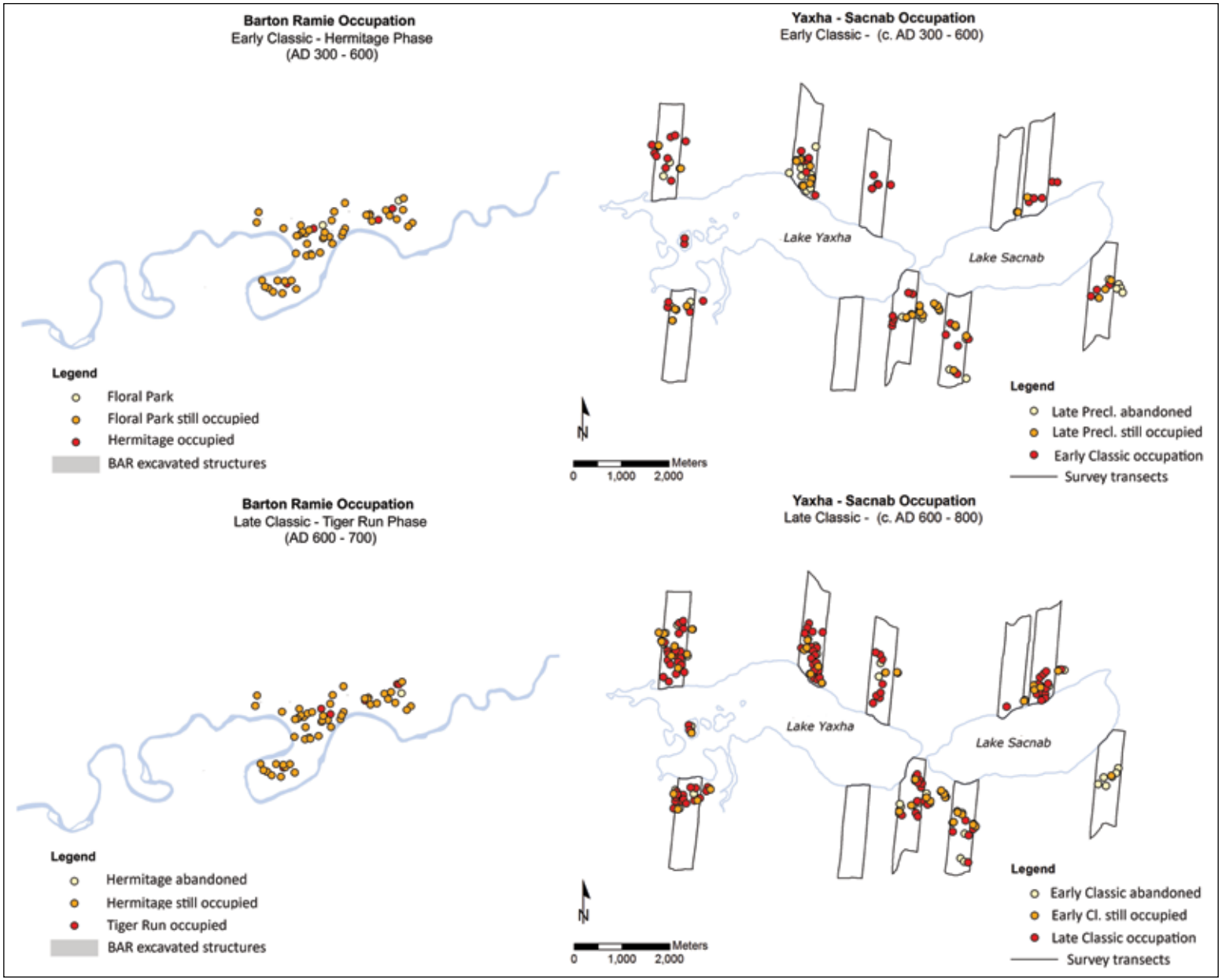


Figure 6.12 and 6.13 a), b) Changes in occupation and spatial distribution of structures during Early and Late Classic period in Barton Ramie and Yasha-Sacnab basin.

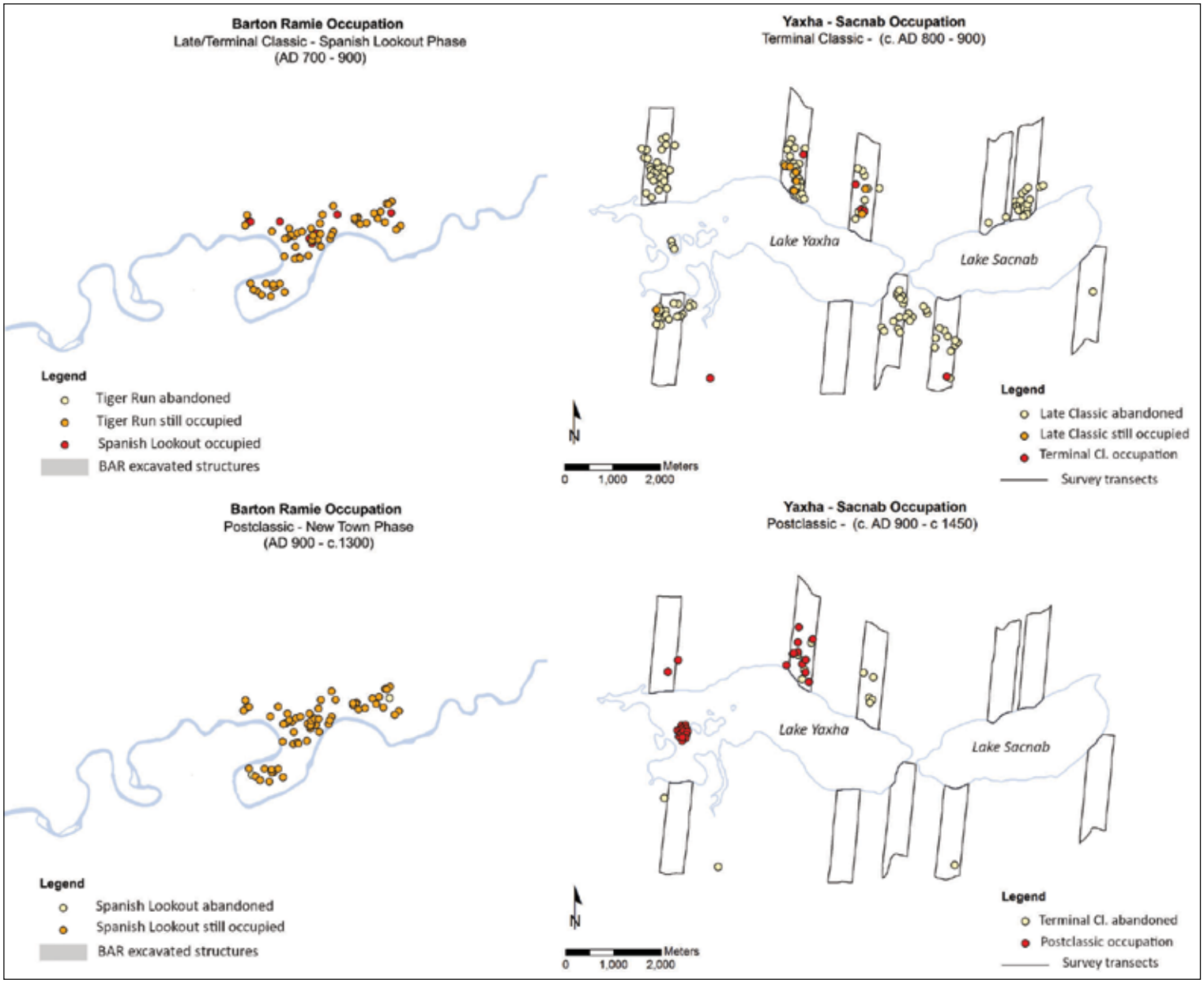


Figure 6.14. and 6.15. a), b) Changes in occupation and spatial distribution of structures during the Late/Terminal Classic and Postclassic period in Barton Ramie and Yaxha-Sacnab basin.

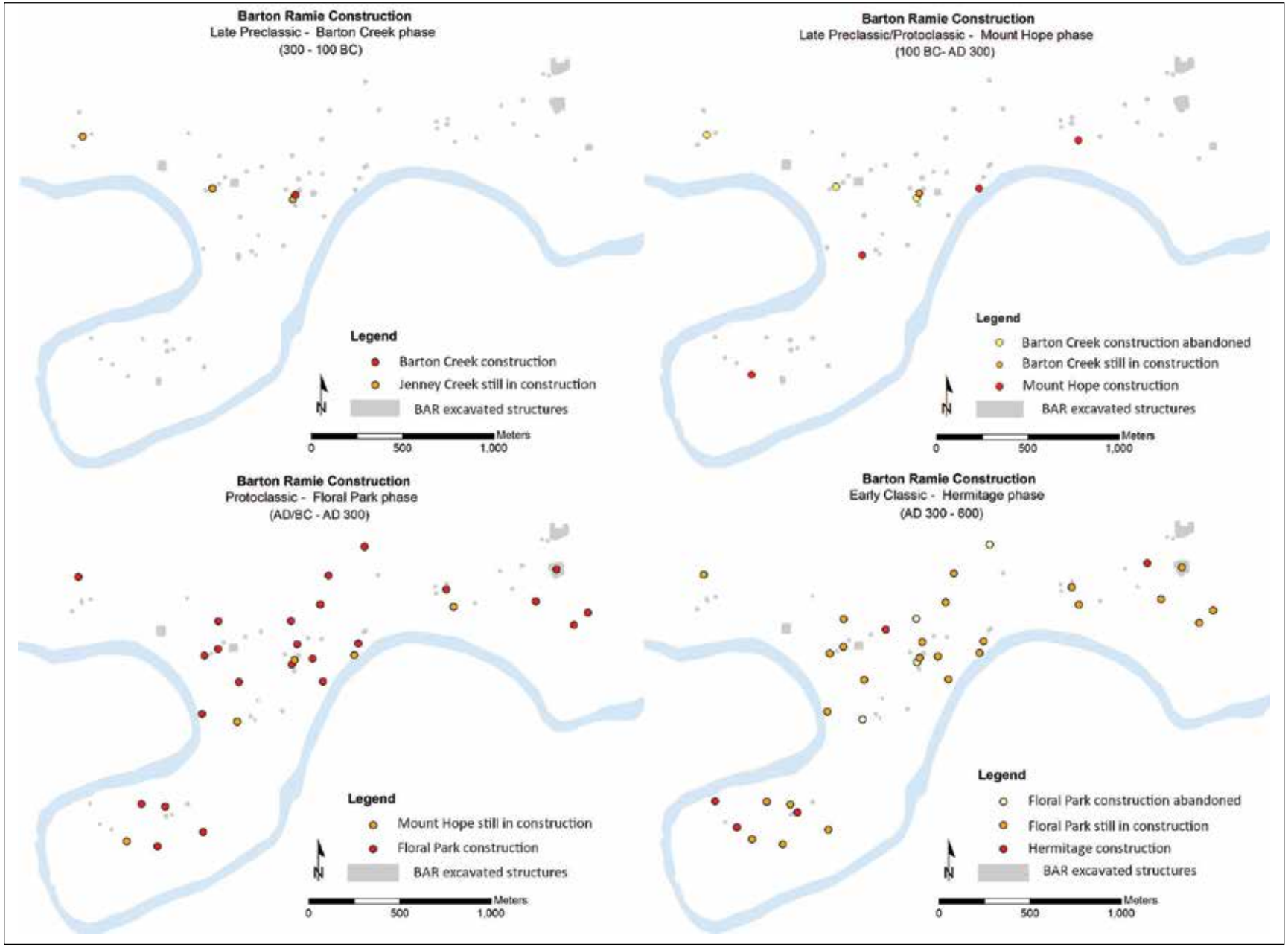
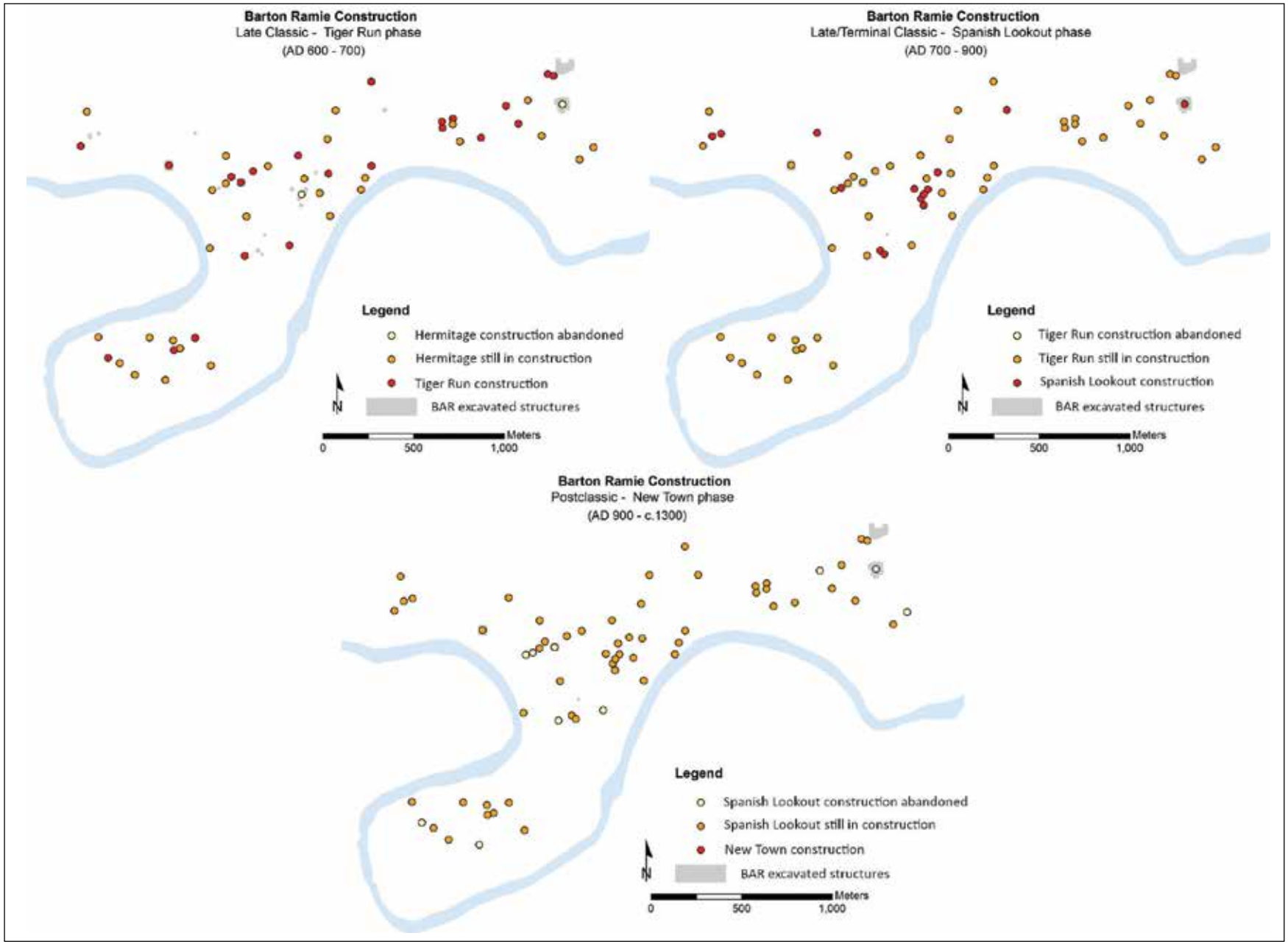


Figure 6.16. a) to d) Change in construction activity from the Late Preclassic until the Early Classic period in Barton Ramie.



Figures 6.16. e) to g) Change in construction activity from the Late Classic until the Postclassic period in Barton Ramie.

Macanche Lakes, Zacpeten peninsula and the Isthmus of Ixlu and Muralla de Leon (Rice and Rice 1980; D. Rice 1986: 309–310)). While there appears to have been nucleation at a larger scale, the Postclassic structures do not seem to be formally organised into patio groups or plazas, but rather usually stand alone; in many cases, settlers seem to have avoided using the architecture of earlier periods (D. Rice 1986: 310). The avoidance of earlier structures was also noticed in other areas and will be discussed further below. If structures are clustered into groups, it is usually due to terrain requirements, as these structures share terraces; they do not share any formal organisation or alignment (Bullard 1970, fig. 12). Bullard argues that this was not only true for commoner households but also applied to the ceremonial structures. During the mapping of the Postclassic site of Cante, where the majority of structures have been dated to the Late Postclassic (D. Rice 1986), Bullard (1970) observed that even the ceremonial structures arranged around the plaza were far from being at right angles to one another (e.g., Fig. 6.4). Similarly, Johnson, after performing a quantitative analysis of alignments of all the structures on Cante Island (comparing the structural alignments between each structure and its nearest neighbour, up to the eighth neighbour), argued that alignment seems to be determined by the direction of the slope rather than by the adjacent structures. This apparent disregard for inter-structure alignment and orientation seems to be typical for Postclassic settlement and, according to Johnson, it is 'one of the major differences between the organisation of Classic and Postclassic sites in Petén' (1985: 152).

6.3.2. Northern Yucatan Peninsula

There have been several different survey projects conducted in the northern Yucatan Peninsula. One of the most heavily investigated parts is the northwest corner, where research has been carried out since the early 1950s (e.g., Shook 1955; Andrews and Andrews 1980; Garza de González and Kurjack 1980; Ringle 1985; Ringle and Andrews 1990; Andrews and Ringle 1992). The data used here to examine the occupational changes in the northwest come from one of the most recent and most spatially and temporally intensive surveys conducted by the Proyecto Costa Maya (PCM), directed by Fernando Robles Castellanos and Anthony P. Andrews (2000, 2001, 2003, 2008). The project was in operation mainly between 1999 and 2003 and within that period, it covered an area of approximately 2,200 km^2 and recorded more than 260 precolonial and 160 historic sites (Andrews and Robles Castellanos 2008). For the north central Yucatan, the data used to look at settlement changes on the regional level come from the Cochuah Regional Archaeological Survey (CRAS 2000, 2003, 2004, 2005, 2006, 2008, 2010, 2012), and from the Ek Balam – hinterland Archaeological Project (Houck 2004). For the northeastern corner of the peninsula, data have been drawn from the Yalahau Regional Settlement Pattern Survey (YRSPS, Glover 2006).

(a) Regional change in settlement occupation through time

The comparative occupation data from these regions (Fig. 6.17) have not, to the best of my knowledge, been presented as graphs before. Occupation data presented in the tables and in visual form are expressed both in site counts and in percentages. Cultural periods marked on the x-axis are only approximate because their spans vary, sometimes considerably, among northern lowland regions and sites.

Table 6.5. Occupation distribution across different periods in the northern Yucatan regions: NW Yucatan

NW Yucatan		
Mid Preclassic	700–300 BC	116
Late Preclassic	300 BC–AD 250	92
Early Classic	AD 250–550	111
Late/Terminal Cl.	AD 550–1100	130
Postclassic	AD 1100–1542	21
Colonial	AD 1542–1821	28

Source: Robles Castellanos and Andrews 2003, Table 41.

Table 6.6. Occupation distribution across different periods in the northern Yucatan regions: Ek Balam periphery

Ek Balam periphery		
Mid Preclassic	700–450 BC	10
Late Preclassic	450 BC–AD 1/100	41
Early Classic	AD 1/100–500	36
Mid Classic	AD 500–700	21
Late/Term Classic	AD 700–1050/1100	52
Postclassic	AD 1050/1100–1555	33
Early Colonial	AD 1555–1610	7

Source: Houck 2004: p. 236–243.

Table 6.7. Occupation distribution across different periods in the northern Yucatan regions: Cochuah

Cochuah		
Mid Preclassic	450–250 BC	6
Late Preclassic	250 BC–AD 300	17
Early Classic	AD 300–550	12
Late Classic	AD 550–750	5
Terminal Classic	AD 750–1100	47
Postclassic	AD 1100–1550??	15
Colonial	1550–?	32

Source: Justine Shaw, personal communication 2015.

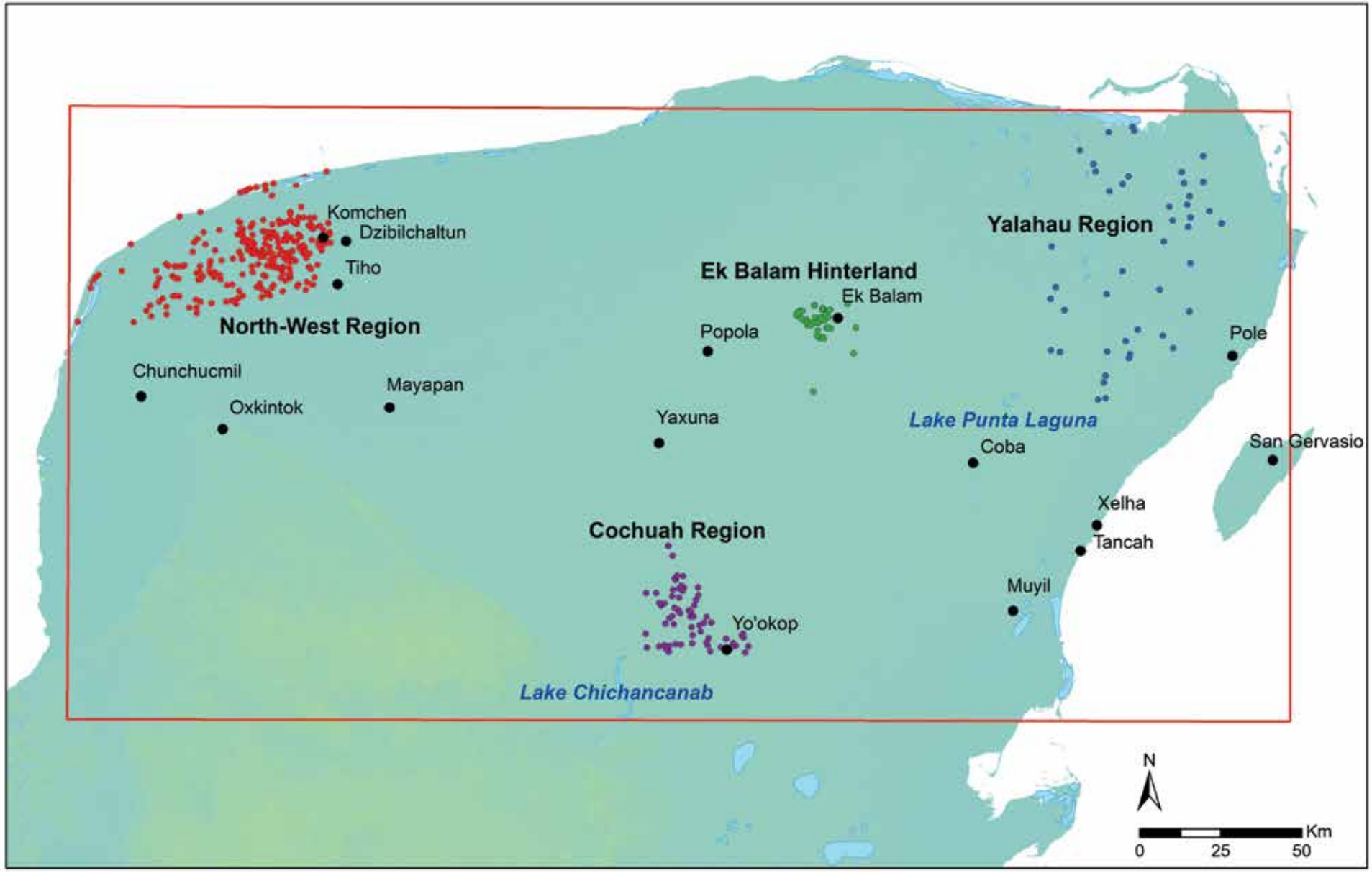


Figure 6.17. Northern Yucatan Peninsula area with individual study regions and sites mentioned in the text.

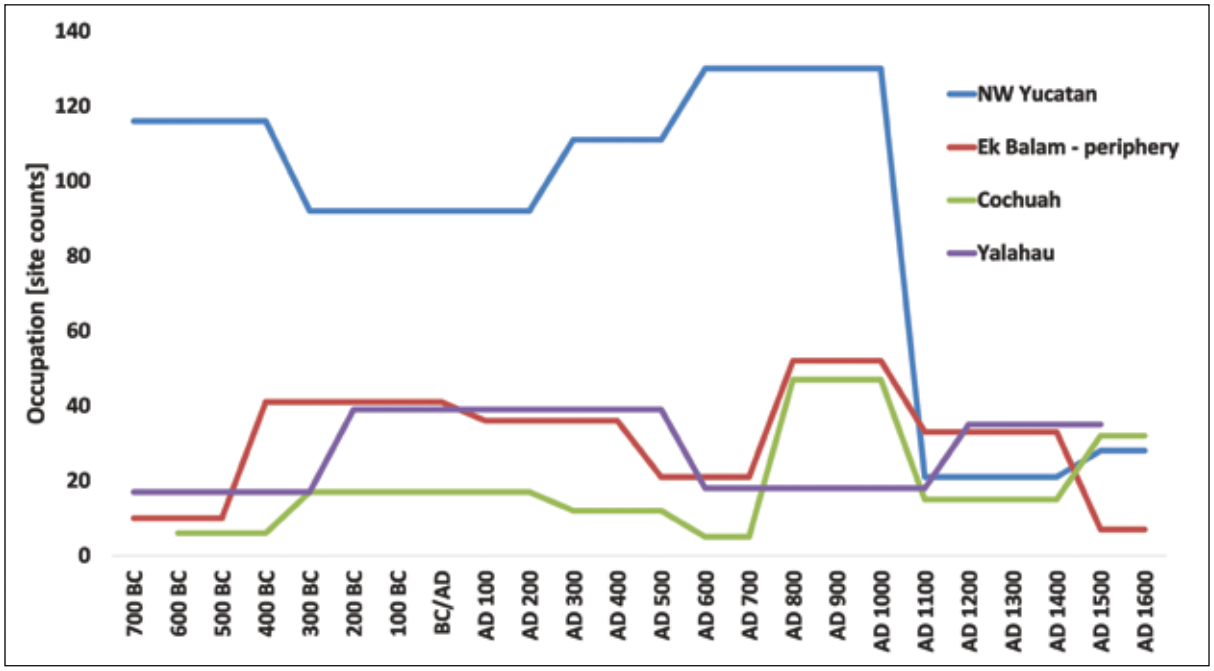
Table. 6.8. Occupation distribution across different periods in the northern Yucatan regions: Yalahau

Yalahau		
Mid Preclassic	700–200 BC	17
Late Preclassic/Early Classic	BC 200–AD 600	39
Late/Terminal Classic	AD 600–1200	18
Postclassic	AD 1200–1521	35

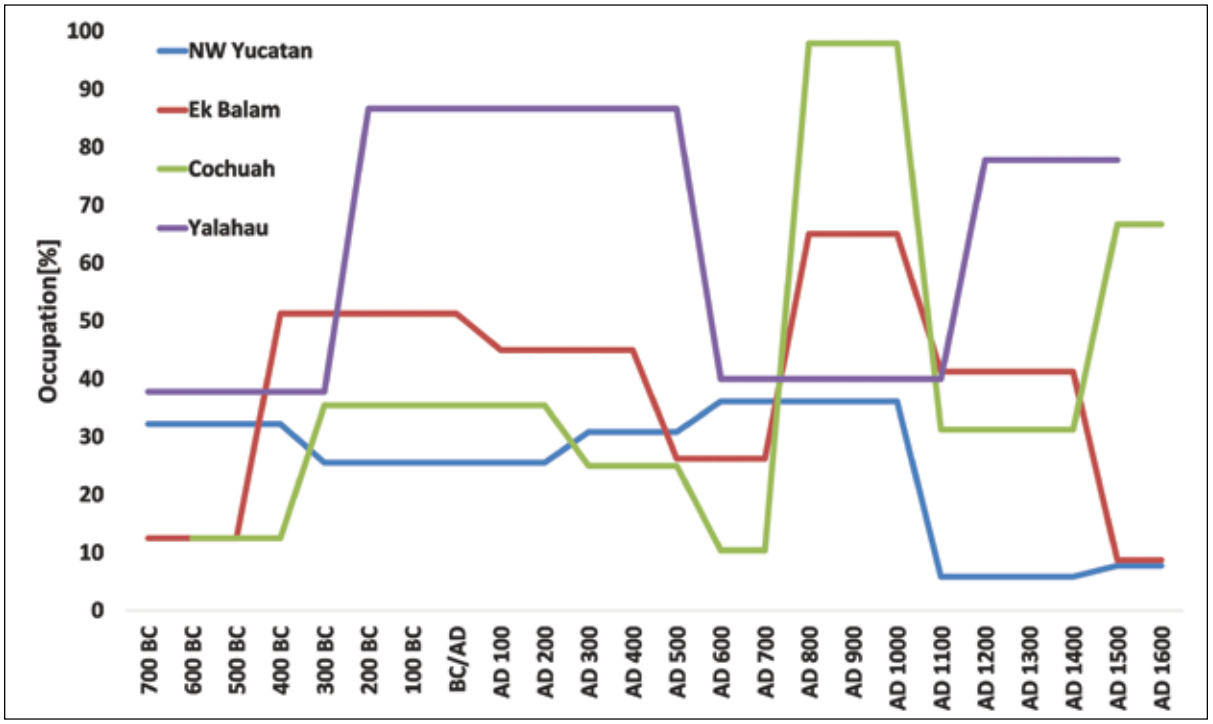
Source: Glover 2006, data: p. 648, 653, 745, 755.

(a) Regional change in settlement occupation – Results

When the occupation histories are compared on a regional scale, we see that there are significant differences between the individual regions (Fig. 6.18). The northwest Yucatan region shows a high occupation rate during both the Early Nabanché (ca. 700–300 BC), corresponding approximately to the Middle Preclassic period, and during the Cehpech (AD 550–1100) or the Late/Terminal Classic period. In contrast to the other three regions, there is a slight decline



(a)



(b)

Figure 6.18. a, b Occupation history in the northern Yucatan regions through time: a) based on site counts, b) based on percentages through approximate cultural periods.

in occupation (5 per cent) after the Middle Preclassic, and another significant drop (by 30 per cent) at the end of the Late/Terminal Classic period, after which the northwest corner of Yucatan was nearly abandoned.

The situation is different in the two inland regions, the Cochuah region and the hinterland area around the site of Ek Balam. Both were very sparsely occupied during the Middle Preclassic period but witnessed significant population increase during the Late Preclassic. Occupation decreased moderately in both regions during the Early Classic (although the span of the period differs slightly between the two regions). Occupation rates further decreased at Ek Balam, and especially in the Cochuah region, during the Late Classic period (ca. AD 500–750). However, the Terminal Classic in the Cochuah region (AD 750–1100), or the Late/Terminal Classic (AD 700–1050/1100) in the Ek Balam region sees a peak in occupation. The Cochuah region, especially, experienced a florescence and a boom in construction activity (Johnstone 2005: 182) and Ek Balam became a dynastic capital with an emblem glyph (Grube, Lacadena and Martin 2003: II–27). After the Terminal Classic, occupation declined in both regions (during the Postclassic). The only difference in the course of occupation between the two regions is that, while occupation declined and Ek Balam was virtually abandoned during the Colonial period, occupation in the Cochuah region increased again.

Finally, the Yalahau region was initially occupied in the Middle Preclassic period and occupation increased significantly during the Late Preclassic (by 49 per cent) and remained stable until the end of the Early Classic. Surprisingly, during the Late/Terminal Classic period, when all of the other regions peaked in occupation, Yalahau's occupation dropped almost to its Middle Preclassic level. Occupation rose again during the Postclassic period, again in contrast to the other three regions, which experienced occupation decline during this period.

In summary, the occupation history in the two inland regions, Ek Balam and Cochuah, is similar, while that of the NW Yucatan region differs from Ek Balam and Cochuah during the Late Preclassic and Early Classic periods, and the occupation of the Yalahau regions is in direct contrast to all the other regions during the Late/Terminal Classic and Postclassic periods.

(b) Local, inter and intra-site changes in occupation through time

For local inter- and intra-site changes in occupation through time, the charts are based on settlement and occupation data from individual sites on the northern Yucatan Peninsula. Data have been drawn from research projects at Dzibilchaltun (Kurjack 1971), Komchen (Ringle 1985), Mayapan (Russell 2008), Ek Balam (Hanson 2008), Popola (Johnson 2012) and San Gervasio at Cozumel Island (Sierra Sossa 1994). In general, sites are drawn from the wider geographical regions discussed above (e.g., Komchen, Dzibilchaltun and Mayapan are located in the northwest Yucatan Region; Ek Balam and Popola are in the central Yucatan region; and San Gervasio is on the northeast coast of the peninsula (Fig. 6.17). The examination of local occupation histories is used to complement observations made on the regional level in order to deepen our understanding of occupation in the northern Yucatan Peninsula in general.

Occupation rates are based on settlement survey and excavations, and in some cases are complemented by surface collections:

- **Komchen**– 40 per cent random sample of structures excavated in each transect (Ringle 1985: 73).
- **Dzibilchaltun** – out of 8, 400 recorded structures (from 19 km² of mapped area), 715 structures were investigated (426 of these were test-pitted), however the data presented in Table 6.10 are based on excavations of 392 unvaulted structures, which were considered a better 'measure of population size through time' than vaulted structures, since most of the people at the site would have lived in the unvaulted structures (Kurjack 1971: 125–127).
- **Mayapan** – 28.5 per cent of structures excavated (Russell 2008, appendix B, 99 structures excavated out of 347 recorded). Unfortunately, data presented in Russell's table 7.1 and used here are based on clusters of structures rather than individual structures; however, upon closer inspection of individual clusters, these in the large majority of cases consist of only one to two structures per cluster and therefore do not affect occupation rate significantly.
- **Popola** – 20 per cent of structures excavated (Johnson 2012: 180–221); however the data are based on surface collection as well, so 41 structures tested out of 110; therefore, data are based on 37.3 per cent sample, including surface collection.
- **Ek Balam** – 20 per cent stratified random sample of structures were test-excavated (Hanson 2008: 844–845).
- **San Gervasio** – 80 per cent of structures excavated (Sierra Sosa 1994: 83).

(b) Local, inter and intra-site changes in occupation – Results

On the local level (Fig. 6.19 a, b), the site of Komchen, in the northwest corner of Yucatan, was (together with Xtobo) a large regional centre (a top-tier settlement in the three-tiered hierarchy of Preclassic sites established by Proyecto Costa Maya, which distinguishes small, medium and large sites: Anderson 2010, 2011). Results show a peak in Komchen's occupation already in the Late Preclassic period, during which time it served as a major centre in the area (Cottier 1982: 216). Although no structural remains have been identified for the earlier periods, investigators argue that based on ceramics there was substantial occupation at Komchen already during the Middle Preclassic. However, structures would have been constructed of poles and thatch and built directly on the surface rather than on the platform (Ringle and Andrews

Table. 6.9. Occupation distribution across different periods in Komchen

Komchen	Cultural periods	Dates	No. of structures
Middle Preclassic	**Early Nabanche**	600–450 BC	0
Late Preclassic	**Ek**	450–350 BC	6
	Late Nabanche	350–150 BC	19
	Xculul	150 BC–AD 250	42
Early Classic	**Piim**	AD 250–600	0
Late Classic/Term. Cl	**Copo**	AD 600–1000	52
Early Postclassic	**Zipche**	AD 1000–1200	2
Late Postclassic	**Chechem**	AD 1200–1546	6
Total			**162**

Source: Ringle 1985, data: p.363, table 4.1, and Ringle and Andrews 1990, p.243.

Table 6.10. Occupation distribution across different periods in Dzibilchaltun

Dzibilchaltun		Cultural Periods	Dates	No. of structures
Middle/Late Formative	Middle/ Late Preclassic	**Nabanche/Xculul**	700 BC–AD 250	103
Early period I	Early Classic	**Piim**	AD 250–600	16
Early Period II/Pure Florescent I	Late/Terminal Classic	**Copo**	AD 600–1000	355
Modified Florescent period II	Early Postclassic	**Zipche**	AD 1000–1200	11
Decadent period	Late Postclassic	**Chechem**	AD 1200–1500	16
Total				**392**

Source: Kurjack 1971, p.227, Table 4, new chronology based on Cotier 1982, p. 15.

Table. 6.11. Occupation distribution across different periods in Mayapan-hinterland

Mayapan-hinterland	Dates*	No. of Clusters**
Early Classic	AD 300–600	1
Terminal Classic	AD 800–1100/1200?	14
Postclassic	1100/1200?–1550	157
Total		**172**

*1 or 2 structures per cluster, **chronology based on Smith 1971.

Source: Russell 2008, data: p. 512, Table 7.1.

Table 6.12. Occupation distribution across different periods in Popola

Popola	Dates	No. of structures
Middle Preclassic	500–250 BC	19
Late Preclassic	250 BC–AD 250	14
Early Classic	AD 250–600	10
Late Classic/Terminal Classic	AD 600–1100	37
Postclassic	AD 1100–1550	6
Colonial	1550–	1
Total		**41**

Source: Johnson 2012, data: page 224, table 7.2.

Table 6.13. Occupation distribution across different periods in Ek Balam

Ek Balam	Cultural periods	Dates	No. of structures
Mid Preclassic	**Balam**	700–450 BC	3
Late Preclassic	**Manab**	450 BC–AD 1/100	47
Early Classic	**Alux**	AD 1/100–500	83
Mid Classic	**Early Yumcab**	AD 500–700	69
Late/Term Cl.	**Late Yumcab**	AD 700–1050/1100	69
Posclassic	**Xtabay**	AD 1050/1100–1555	60
Early Colonial	**Cizin**	AD 1555–1610	40
Total			**130**

Source: Hanson, 2008, data: pages 955, 1077, 1204, 1284

Table 6.14. Occupation distribution across different periods in San Gervasio

San Gervasio	Cultural periods	Dates	No. of structures
Early Classic?	**Litoral Cochuah**	AD 200/300–600	20
Late/Terminal Classic?	**Ribera Cehpech**	AD 600–900/1000	32
Early Postclassic?	**Arrecife Sotuta-Hocaba**	AD 900/10000–1200	49
Late Postclassic	**Costa Tases**	AD 1200–1550	87

Source: Sierra Sosa 1994, data: p. 18, Fig. 14; p.58, Fig. 18; p.88, Fig. 23; p. 102, Fig. 34.

Table 6.15. Summary of the occupation rates for individual sites based on percentages

Periods	Komchen [%]	Dzibilchaltun [%]	Mayapan [%]	Popola [%]	Ek Balam [%]	San Gervasio [%]
Middle Preclassic		26.28		46.34	2.31	
Late Preclassic	45.06	26.28		34.15	36.15	
Early Classic	0.00	4.08	0.58	41.46	63.85	20.83
Late/Term. Classic	32.10	90.56	8.14	90.24	53.08	33.33
Early Postclassic	0.62	2.81	91.28	14.63	46.15	51.04
Late Postclassic	2.47	4.08	91.28	14.63	46.15	90.63
Early Colonial				2.44	30.77	

1990: 222), and thus would not have preserved well. This corresponds with the high Middle Preclassic occupation rates observed on the regional scale (Fig. 6.18). After the peak in occupation during the early phase of the Late Preclassic (Late Nabanche Phase, ca. 350–150 BC), occupation decreased in the later Xculul phase (ca. 150 BC–AD 250) and there was no occupation identified at Komchen for the Early Classic period (which corresponds again with the general demographic decline in the NW region at the end of the Preclassic). Komchen was reoccupied again during the Late/Terminal Classic period (mostly in the Terminal Classic), although the occupation rate did not reach the early Late Preclassic level and, according to investigators, it consisted to a large extent of the reoccupation of old platforms (Ringle and Andrews 1990: 225). After the Terminal Classic period, Komchen is essentially abandoned, with only one or two structures showing any traces of Postclassic activity; these are small shrines rather than residential structures (Ringle and Andrews 1990: 225). Komchen's history of occupation is closely tied to that of other sites in the area, such as Dzibilchaltun and Tiho.

The site of Dzibilchaltun, located only 7.6 km east of Komchen, shows similar cycles of occupation growth and decline. It was occupied from the Middle Preclassic period, with a significant growth in occupation during the Late Preclassic (Kurjack 1971: 225; Cottier 1982: 198). As at Komchen, the evidence of occupation during the Early Classic period is almost nonexistent. In contrast, the Late Classic represents another period of growth and expansion, when Dzibilchaltun became a major centre, (this might have had an effect on the reoccupation and growth of Komchen as well). During the Terminal Classic period, Dzibilchaltun

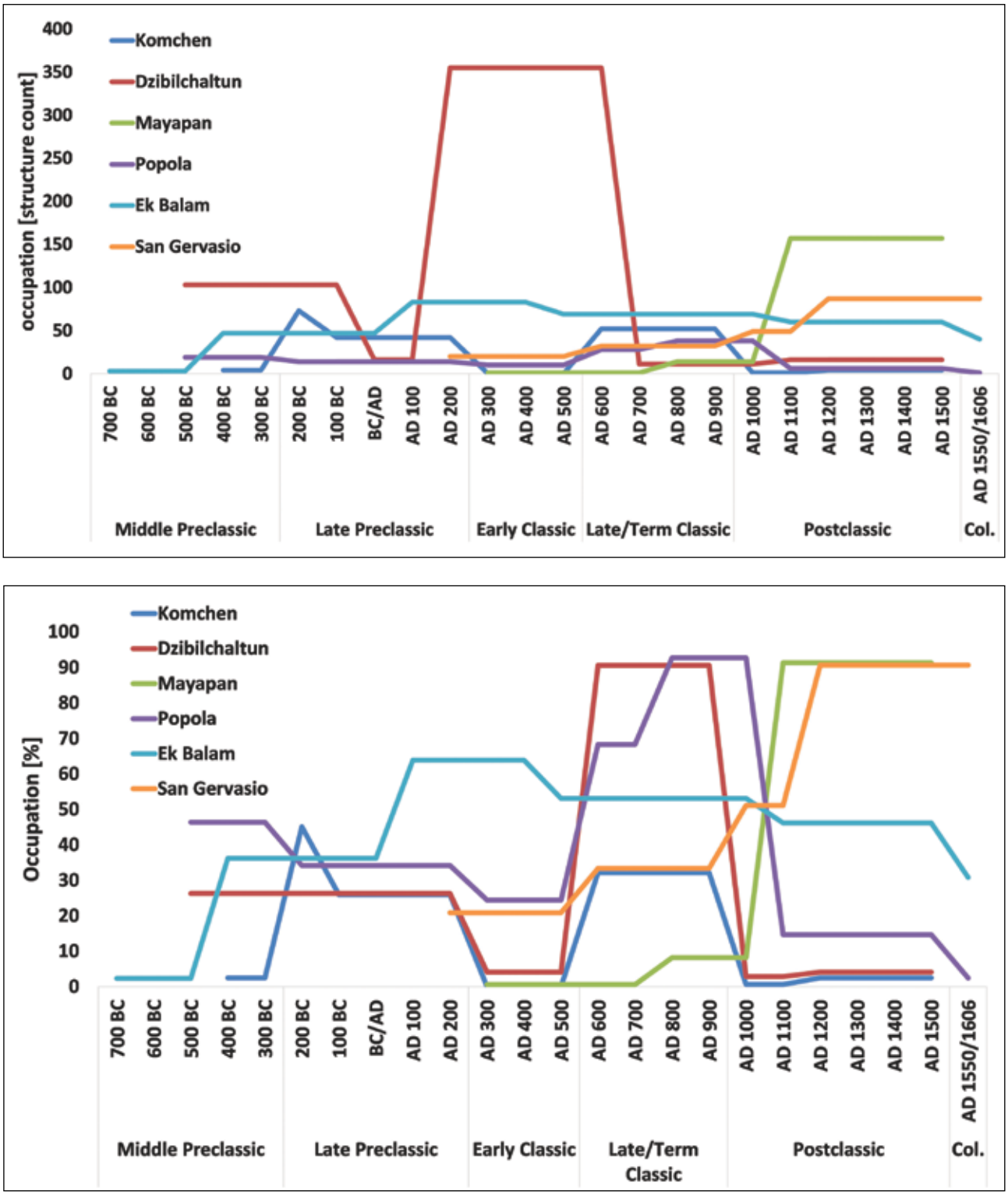


Figure 6.19. a, b. Occupation history of individual sites through time: a) based on structure counts, b) based on percentages through approximate cultural periods.

experienced another decline in occupation, most likely related to the rise of Tiho, located 14 km to the south (Andrews V 1981: 333; Cottier 1982: 210). The decline of Dzibilchaltun continued into the Early Postclassic period, at which point it was reduced from a major centre to a possible subsistence area for Tiho. The Late Postclassic period shows a small increase in activity: modification of structures as opposed to their simple reuse during the Early Postclassic, stelae dedication revival, and construction of single-room shrines (Andrews IV and Andrews V 1980: 312–313 cited in Cottier 1982: 213). All of this indicates ritual activity and the possible ceremonial function of the site during this period (Andrews V 1981: 338).

Similar occupation trends to Komchen and Dzibilchaltun were observed at other sites from the northwest Yucatan

region, especially with regards to the significant population decline in the Early Classic period. There is, however, variation in the occupation histories within the region. For example, the site of Chunchucmil was occupied from the Middle Preclassic (750/700–350/300 BC) until the Postclassic period (AD 1100–1550), although the Postclassic occupation seems to have been very small and most likely non-permanent (Magnoni 2008: 117–118). The site experienced a peak in population density and large site expansion during the latter part of the Early Classic and the beginning of the Late Classic (AD 400–650/700), and during the Late Classic period it became a thriving trading centre with an unusually high structure density for a Maya city (Magnoni 2008: 123). Similarly, Oxkintok, which was occupied from the Preclassic until the Postclassic period (ca. 600 BC–AD 1500), shows considerable occupation and construction activity during the late Early Classic and early Late Classic period (AD 500/550–600/630; Varela Torrecilla and Braswell 2003). Unlike at Komchen, however, Chunchucmil's decline started during the Late Classic (ca. AD 650–750) and continued during the Late/Terminal Classic, which shows drastic decrease in occupation and in the size of the city, and significant changes in settlement patterns. At Oxkintok, this period (AD 600–710/740) indicates the beginning of cultural discontinuity and cessation in construction of large pyramidal structures (Muños Cosme 1990; Rivera Dorado 1996 cited in Magnoni 2008: 110). For the Postclassic period, there is only scant evidence of occupation, most likely intermittent, at Chunchucmil (Magnoni 2008: 123); Oxkintok shows similar trends (Magnoni et al. 2012).

Returning to Fig. 6.19 and moving in a west to east direction, the site of Mayapan is located 40 km southeast of Tiho (the modern city of Merida) and 100 km west of Chichen Itza. The data presented here for the site of Mayapan represent the occupation of Mayapan's 'periphery', that is, beyond the wall surrounding the centre of the city (Russell 2008). Although no structures were identified for the Preclassic period, ceramics indicate that Mayapan was occupied from the Late Preclassic period (Russell 2008: 500). The occupation expanded significantly only at the beginning of the Terminal Classic period, but Mayapan experienced rapid growth and an occupation peak during the Postclassic, reaching a population density unusual for Classic period Maya cities. Mayapan became the largest inland city occupied during the Late Postclassic period (AD 1200–1540), serving as cultural and political capital and controlling a large portion of the Yucatan Peninsula (Peraza Lope et al. 2007; Pugh 2001). Mayapan's decline was as sudden as its rise, however, as its occupation during the Colonial period is virtually non-existent (Russell 2008).

The next site, Popola, is a small site, but it is located between two large and important northcentral Yucatan sites, 5 km northeast of Yaxuna and 13 km southwest of Chichen Itza and its occupation history is related to that of its large neighbours (Johnson 2012). As shown in Fig. 6.19, Popola was occupied from the Middle Preclassic period, with only small changes in occupation rates until the Late and especially Terminal Classic period, when it reached a peak in occupation (93 per cent of structures occupied). Occupation rates declined significantly during the Postclassic period (15 per cent) and the site was essentially abandoned during the Colonial period (2 per cent).

The increase in the occupation rate at Popola during the Terminal Classic period corresponds with the major growth and florescence of Chichen Itza between AD 900 and 1200, when the city became a regional capital, dominating large parts of the northern Maya lowlands (Andrews and Robles Castellanos 1985: 65–66; Robles Castellanos and Andrews 1986: 83). Yaxuna, on the other hand, experienced rapid demographic collapse at this time (ca. AD 900; Johnson 2012: 73). The site of Yaxuna was occupied during the Middle Preclassic period, probably from approximately 500 BC, but experienced major growth during the Late Preclassic, from approximately 250 BC. It continued growing during the Early Classic (AD 250–600), showing substantial construction activity in the early phase of the period. However, the end of the Early Classic at Yaxuna is characterised by 'violence and ritual terminations' (Suhler et al. 1998: 177). There is evidence of recovery during the Late Classic and another period of increased construction activity and population boom during the beginning of the Terminal Classic (Suhler et al. 1998: 177). This period of renewed activity was short-lived however, as by AD 900, Yaxuna shows a drastic reduction in occupation (Johnson 2012: 73). Although there is evidence of some, mostly ceremonial, activity during the Postclassic period, no evidence of construction activity, other than small altars and shrines, or signs of occupation was recovered (Suhler 1998: 179).

The situation is in some respects similar further northeast at the site of Ek Balam. Ek Balam is located 51 km northeast of Chichen Itza and 60 km northwest off Coba. The city was occupied from the Middle Preclassic through to the Colonial period. Fig. 6.19 shows significant increase in occupation during the Late Preclassic period, which continued during the Early Classic – the peak in Ek Balam's occupation. After the Early Classic, occupation gradually decreased throughout the Late Classic, Postclassic and Colonial periods (although 30.7 per cent of structures were still occupied during the Colonial period). Furthermore, although there was considerable occupation recorded during the Postclassic period at least in some sectors of Ek Balam, it seems that this consisted mainly of the reoccupation of existing structures rather than new construction activity (Hanson 2008: 1286; Ringle et al. 2004: 501–502). It has been suggested that the decline of Ek Balam might be related to channelling all resources into competitive construction projects, leading eventually to the loss of power when Ek Balam was outcompeted by Chichen Itza (Ringle et al. 2004: 512–514). Some parts of Ek Balam were still occupied during the Colonial period, but after 1582, Ek Balam disappeared even from Colonial documents (Hanson 2008: 610).

The last site shown in Fig. 5.19 has a very different occupation history. At San Gervasio, located on Cozumel Island, the earliest occupation was in the Litoral Cochuah phase (ca. AD 200/300–600), corresponding roughly to the Early Classic period. After that, occupation increased gradually during the Ribera Cehpech (ca. AD 600–900/1000) phase or the Late Classic/Terminal Classic period, and the Arrecife Sotuta-Hocabá phase (ca. AD 900/1000–1200) or the Early Postclassic. The most significant expansion and peak in the San Gervasio occupation occurred during the Costa Táses (ca. AD 1200–1550) phase or the Late Postclassic period. After the Late Postclassic, occupation of San Gervasio was reduced to a few peasant families, but it was still visited as a place of worship at the start of the Colonial period (Sierra-Sossa 1994: 113). A similar occupation history is shown at other sites on the east coast of the peninsula, such as Tulum, Tancah, Xelha and Pole (Xcaret). Although it was assumed that not many sites on the east coast were occupied before the Postclassic period, recent research shows that there was occupation from as early as the Middle Preclassic period. For example, the site of Muyil/Chunyaxché, located near the east coast, 42 km southeast from Coba, may have been occupied by the end of the Middle Preclassic period (ca. 400 BC, which is earlier than Coba) (Witschey 2005: 137). The population at Muyil grew gradually during the Early and Late/Terminal Classic periods, and the Early Postclassic (Chunkopo ceramic complex, AD 1000–1200) also shows considerable construction activity at Muyil, Tancah and Chamax. The construction programs at Muyil continued during the Late Postclassic (Chunchukum ceramic complex, AD 1200–1550) and there is evidence of dense occupation at the centre, with estimated population growth of 25 to 75 per cent and general expansion of the city (Witschey 1993: 224).

(c) Regional settlement pattern changes through time – Nucleation and dispersal of settlement

The diachronic analysis of settlement organisation on the regional scale was performed to explore spatial distributions of settlements and their changes through time, especially with regards to nucleation and dispersal of occupation (Figures 6.20–6.25).

(c) Nucleation vs dispersal of settlement – Results

The diachronic analysis of settlement organisation on the regional scale in Figures 6.20–6.25 shows rates of occupation and stages of dispersal/nucleation in individual regions and the differences between them. The changes in occupation rates in these regions were described above, but here I would like to draw attention to the spatial distributions of settlements and their changes through time. The main focus of Figs. 5.20–5.25 is correlation between the rate of occupation and the nucleation of the settlement. For example, the northwest Yucatan region shows relatively dense, nucleated settlement both during the Middle Preclassic and the Late/Terminal Classic periods, which are periods with highest rates of occupation (Fig. 6.20 and 6.23). A similar pattern is observable for the Cochuah region. The low dispersed occupation in the Cochuah region grew during the Late Preclassic period and became more nucleated as population increased. During the Early Classic, Cochuah's occupation slightly decreased; however, looking at the map, the settlement did not decrease in size (area occupied) but instead became slightly more dispersed. Settlement dispersal is even more pronounced in the Late Classic, during which time the Cochuah region is almost completely abandoned, in contrast to the Terminal Classic period when the region reached its peak in occupation and again shows a denser, nucleated settlement pattern. Another cycle of dispersal and nucleation in the Cochuah region can be observed during the Postclassic and Colonial periods (Fig. 5.28 and 5.29). Nucleation apparent in the Cochuah region during the Colonial period might be the result of compulsory conversions, accompanied by *congregacion* or forced resettlement of the dispersed Maya population to 'within easy reach of the *doctrina*' (Hanson 2008: 607–608; see also Pendergast et al. 1993: 61; Alexander 2012: 331).

These cycles of dispersal and nucleation of settlement on a regional level are paralleled on the local, intra-site level. At the site of Chunchucmil, the decline in occupation during the Late Classic and especially Terminal Classic period is accompanied by a significant change in settlement pattern. During the Terminal Classic, both the extent of the site and density of occupation decreased dramatically, dropping from the 20–25 km^2 to 1 km^2 and to an extremely low structure density – 90 str/km^2 (Magnoni 2008: 109). The site of Komchen shows the highest degree of nucleation during the phases Xulul (150 BC–AD 250) and Copo (AD 600–1000), which represent peaks in occupation at the site (Ringle 1985: 406, Fig. 5.19). Another example is the site of Mayapan. It experienced the most dramatic changes in settlement patterns, first during the Postclassic period when it rapidly expanded and then during the Colonial period when it was virtually abandoned. The rapidly growing population filled preexisting but not densely settled areas in the Postclassic, and the formal ceremonial centre of the site was established. The resulting settlement was highly compact and reached a density 'more similar to highland, Central-Mexican sites than those seen previously for the ancient Maya' (Hanson 2008: 508). Based on the ethnohistorical documents for Mayapan, it is suggested that the rapid growth of population was a result of resettlement of people from the surrounding areas by Mayapan's elite either by force or by diplomacy (Roys 1962, cited in Hanson 2008: 810). The equally rapid depopulation was then seen as a result of people leaving and returning to their homelands after Mayapan lost its power (Hanson 2008: 810).

Although the high settlement density of Mayapan is unusual for ancient Maya sites, it is not the only case in the northern lowlands and nor it is the earliest example. The above-mentioned site of Chunchucmil reached similar, if not slightly higher, settlement density during the Classic period (AD 400–650). The population density

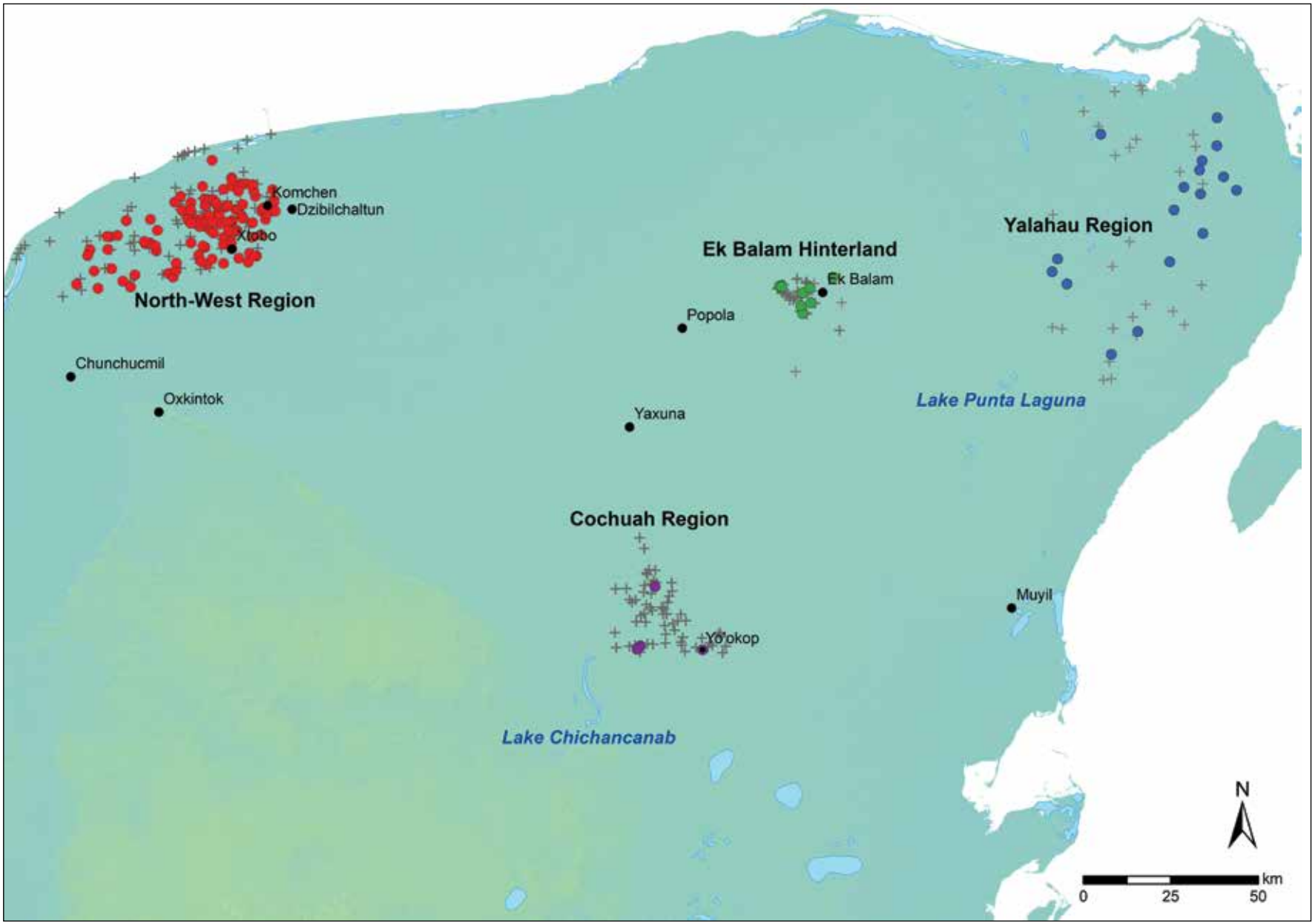


Figure 6.20. Middle Preclassic Period (grey crosses represent all non-focus periods).

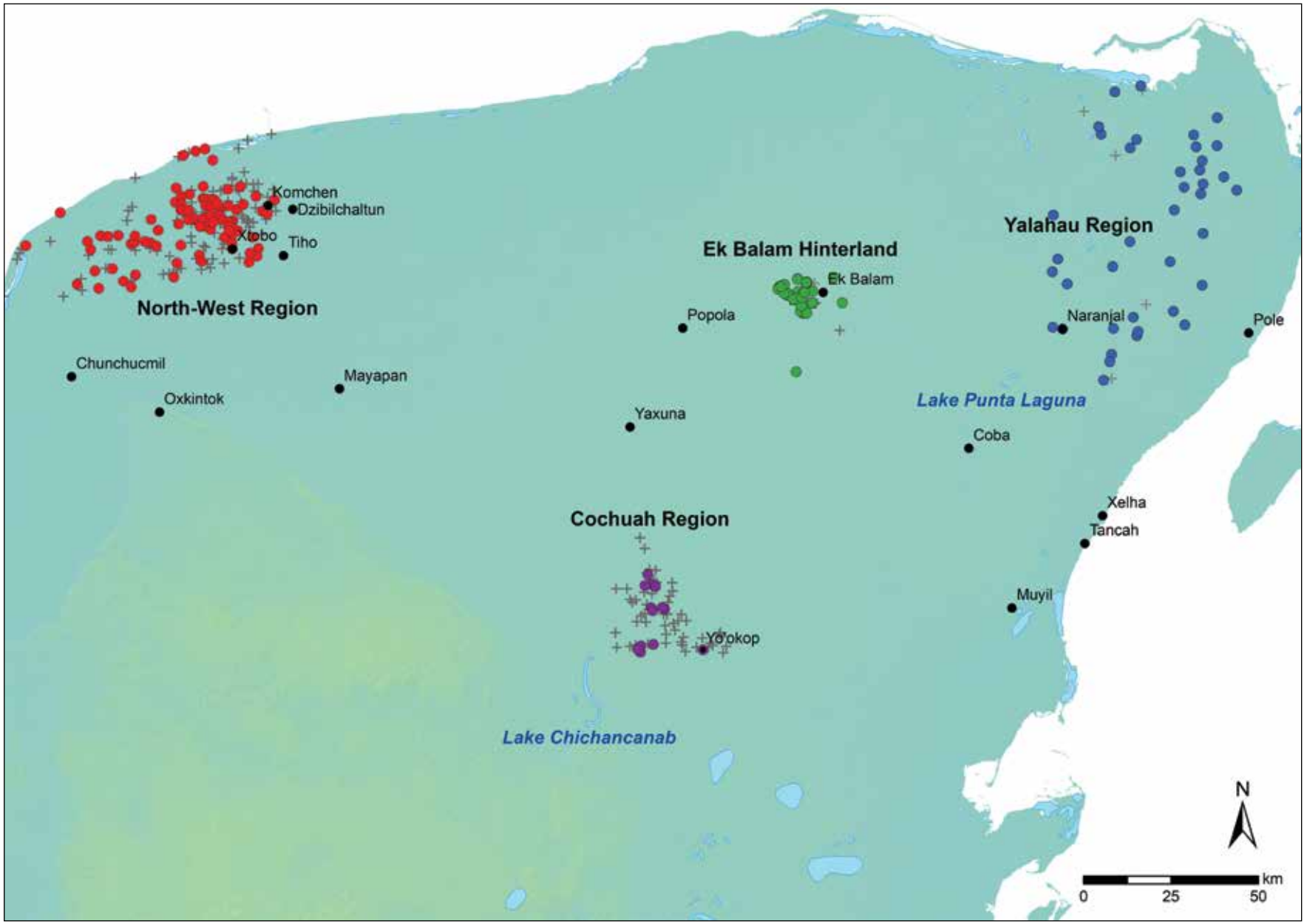


Figure 6.21. Late Preclassic Period.

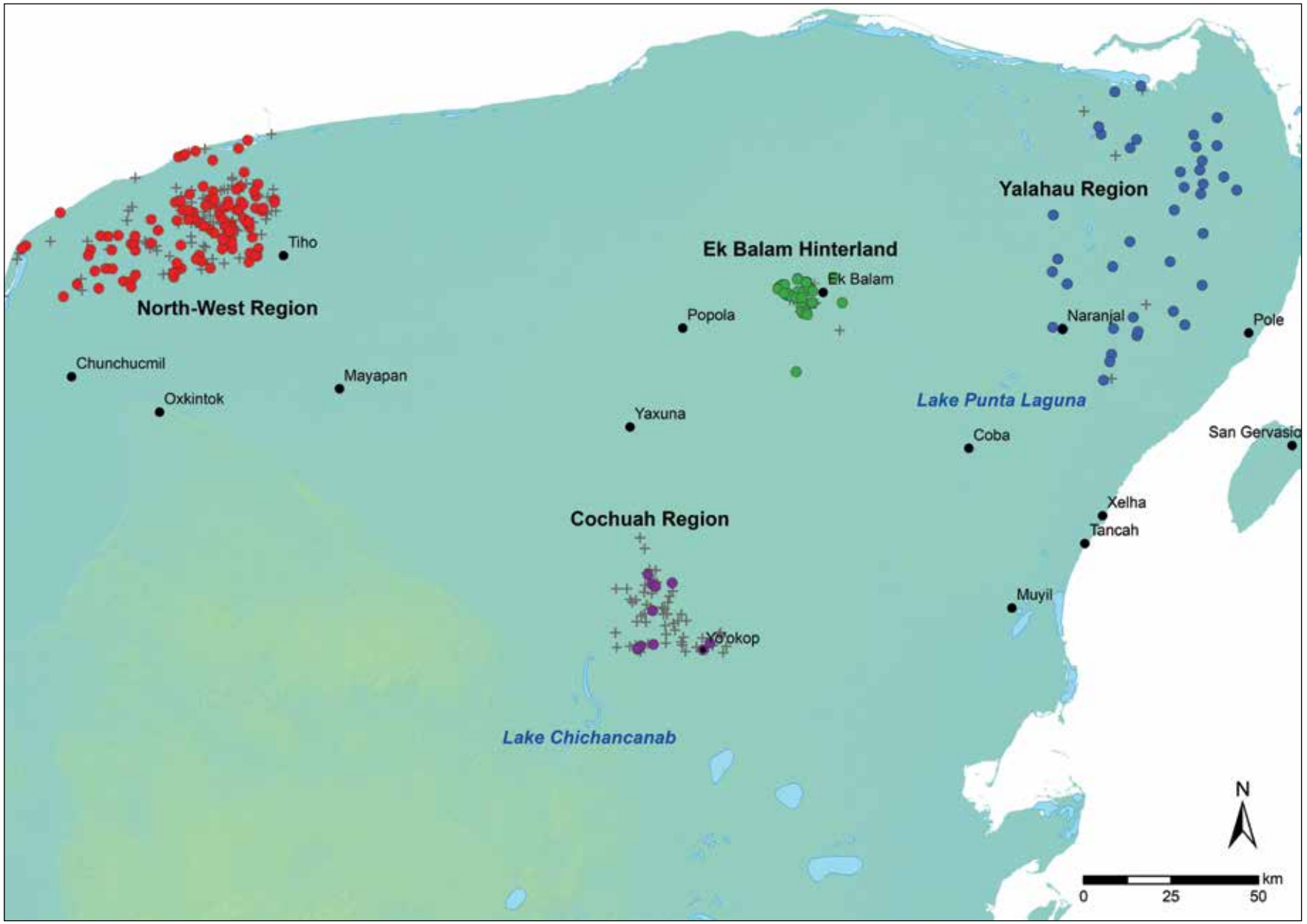


Figure 6.22. Early Classic Period.

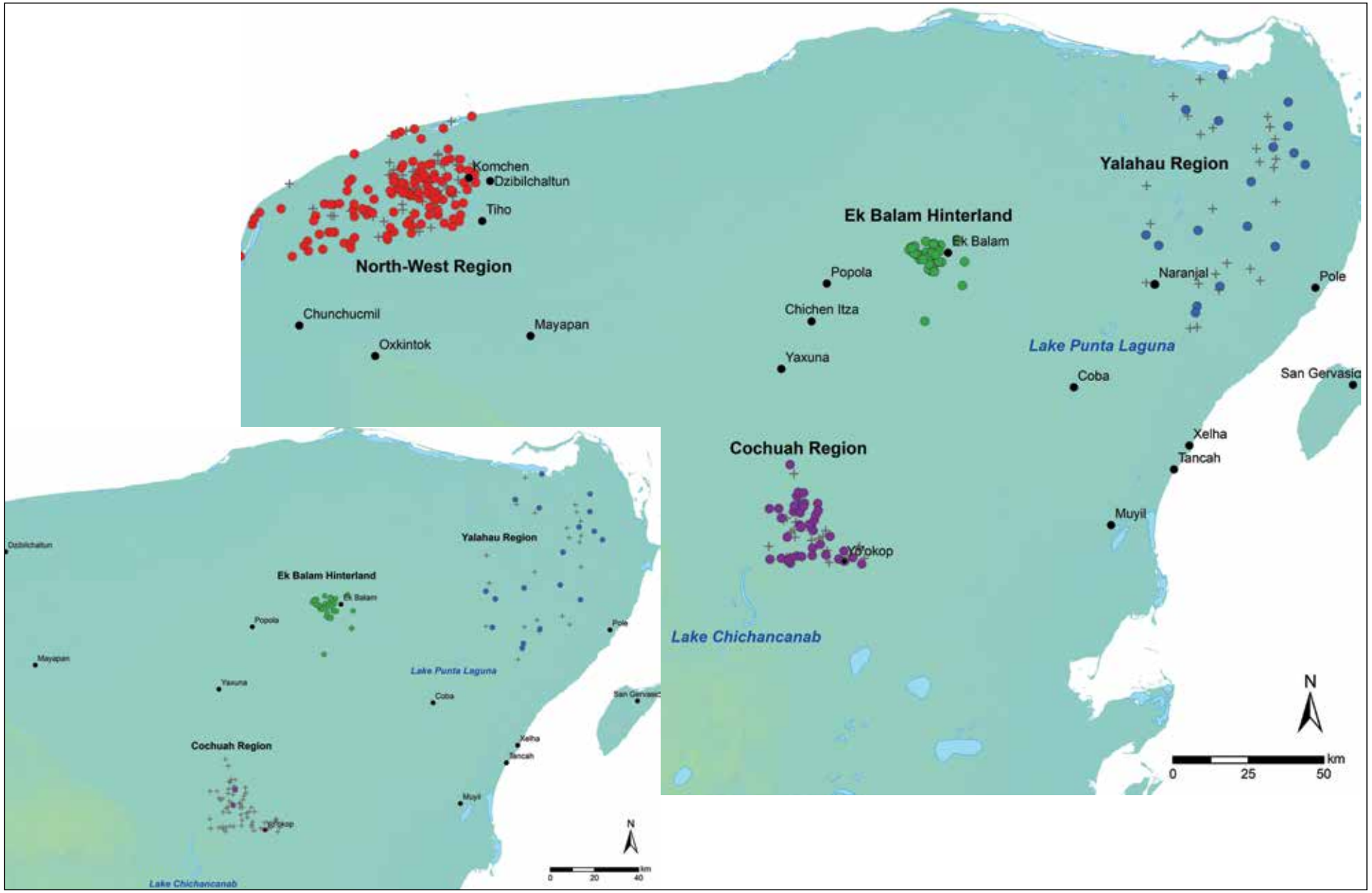


Figure 6.23. Late/Terminal Classic Period (Late Classic – Cochuah Region).

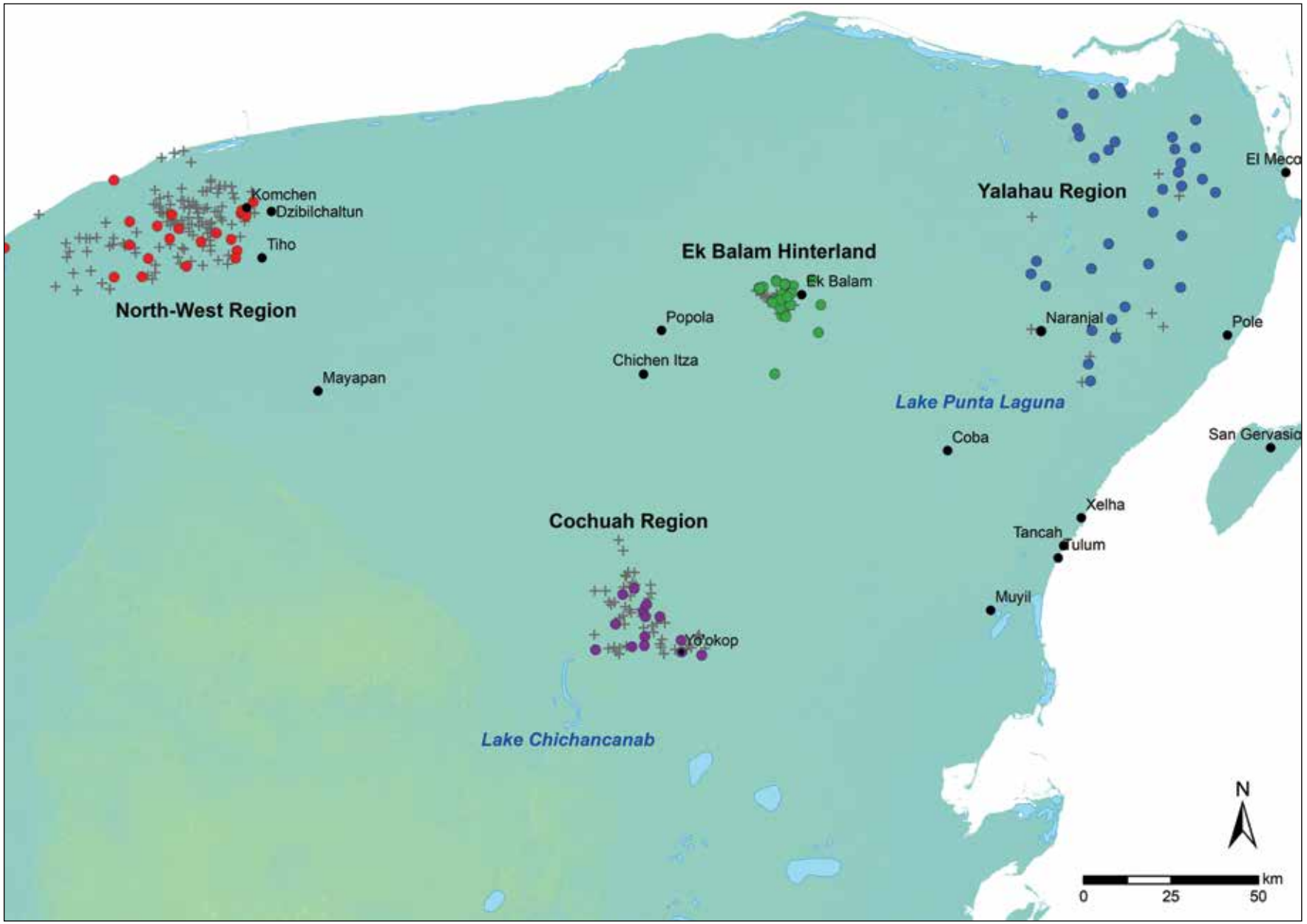


Figure 6.24. Postclassic Period.

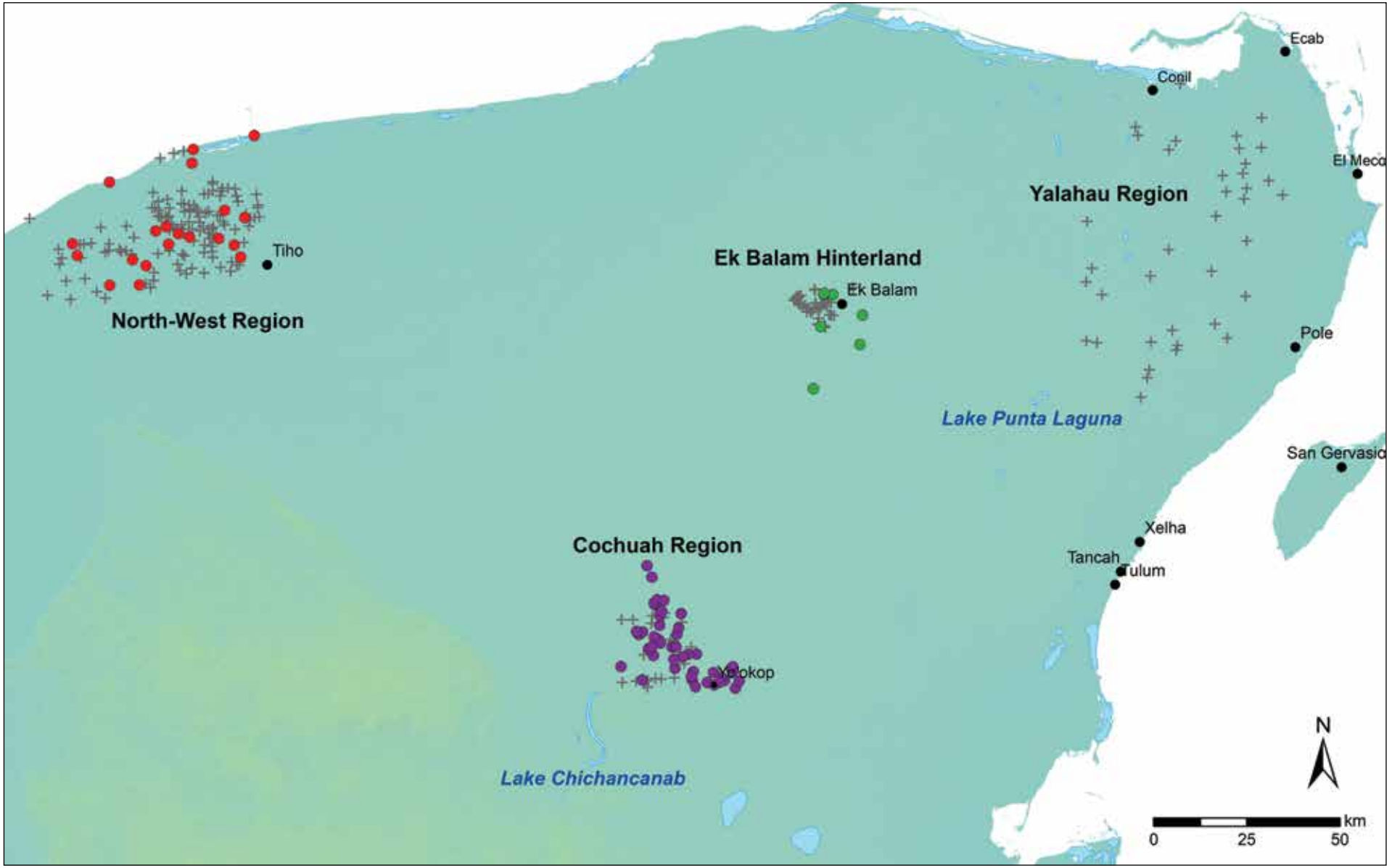


Figure 6.25. Colonial Period.

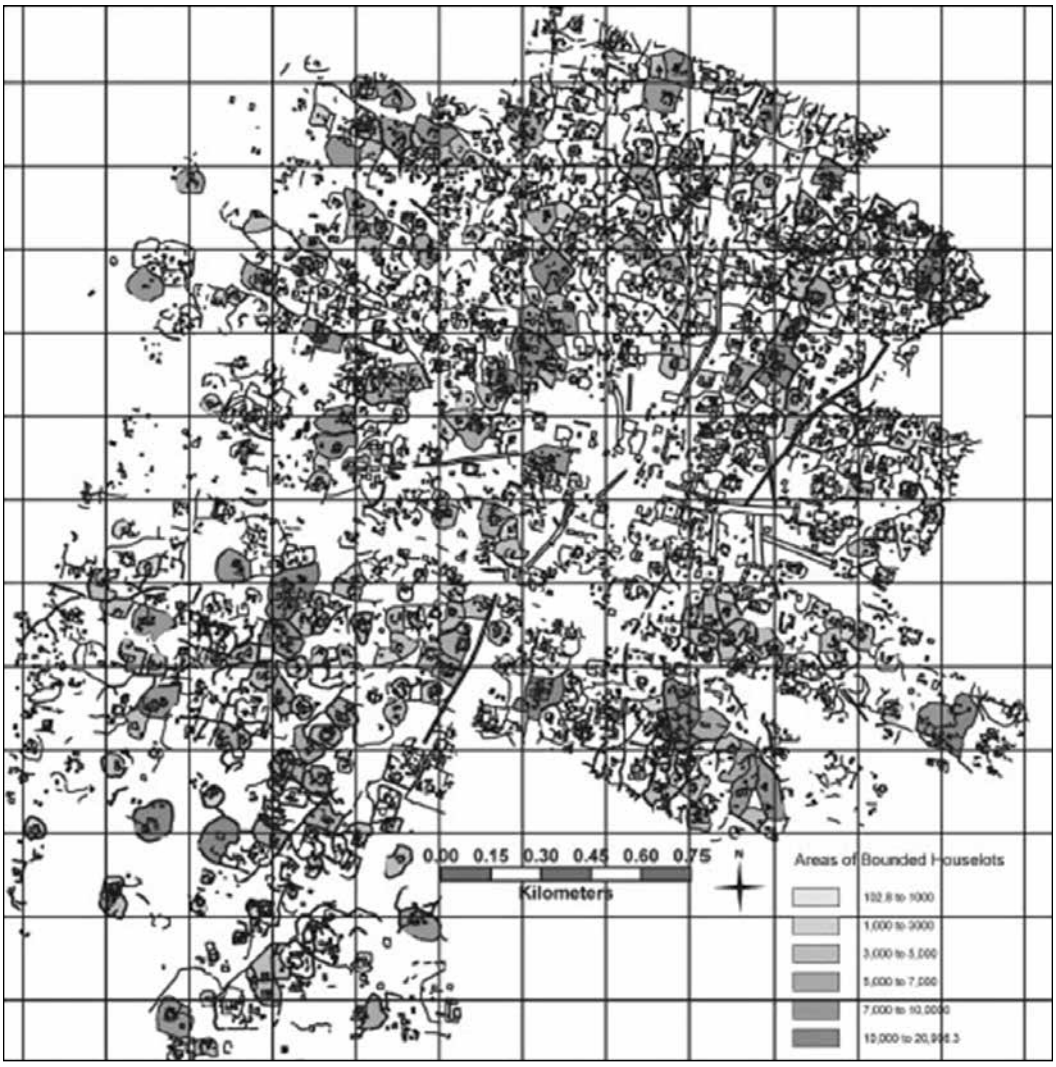


Figure 6.26. Bounded houselots at Chunchucmil (reproduced with permission from Magnoni et al. 2012, Fig. 2).

during its largest occupation was estimated to have been between 34,000 and 43,000 people, within 20–25 km^2 (Magnoni: 2008; Magnoni et al. 2012: 315). In comparison, Mayapan's population estimates are 17,000 people, within an area between 8.8 and 10.1 km^2 (Russell 2008: iii). Chunchucmil's settlement density is unique among the Classic Maya sites, but it is also unusual for its network of stone boundary walls, or *albarradas*, enclosing residential groups and houselots, delimited by narrow streets (Magnoni et al. 2012; Fig. 6.26).

These low stone walls are found at only a few Classic Maya sites: Chunchucmil, Coba, Chichen Itza Dzibilchaltun, Uxmal, Santa Barbara, Becan and in the Rio Bec region. They are slightly more common at Postclassic sites, especially those on the east coast, Tulum, Cozumel, Xamanha and Xcaret, but were also found at Mayapan (Magnoni et al. 2012: 316). Although many buildings are arranged around the patios or plazuelas, indicating integration and social coherence, and streets were highly functional allowing people to move from place to place in the dense settlement, there is no clear evidence of central planning at Chunchucmil (Magnoni et al. 2012: 328).

On the other hand, the settlement organised along the main street in Tulum shows signs of 'town planning and foresight' (Coe 1961: 439). It is argued that this town pattern 'while typical of the Mexican Highlands from an early date, … is unknown in the Maya area in the Classic, and rare in the Post-Classic' (Coe 1961: 439).

Coe also suggested that during the Mayapan period, armed military elements from the highlands forced the northern Yucatecan populations to nucleate for defence and hegemony purposes, although he notes that the settlement patterns of Mayapan and Tulum differ considerably, with only Tulum showing signs of planning (Coe 1961: 439). In the last few years, research has shown that there are sites, such as Nixtun-Ch'ich' in Peten, Guatemala, occupied between approximately 600 and 300 BC (Pugh 2015), and Baking Pot in Belize Valley (Bevan et al. 2013), that show evidence of a gridded layout and, therefore, perhaps some degree of planning.

6.4. Comparison of occupation data with local palaeoclimatic records

The occupation histories for individual regions are compared with palaeoclimatic records in order to assess the possible relationships between changes in occupation and changes in rainfall patterns. Given the large environmental variability of these regions and their highly variable rainfall patterns in particular, I have endeavoured to use as geographically relevant palaeoclimatic records as possible (Fig. 6.27).

6.4.1. Belize Valley and Peten Lakes region

The occupation trends in both regions are compared to palaeoclimatic records. For the Belize Valley, speleothem records from the Macal Chasm cave (Akers et al. 2016) are used, and for the Peten Lakes, the sediment record from Lake Salpeten (Rosenmeier et al. 2002a, 2016) is used. The Macal Chasm and Lake Salpeten records are geographically the closest, with all discussed sites within a 5–40 km radius.

In Fig. 6.28a, the Belize Valley sites' mean occupation rates, based on the mound counts presented in Table 6.3a, are plotted against the Macal Chasm luminescence record, which serves as a long-term proxy for precipitation. The plot does not show a clear relationship between the occupation rates and the amount of precipitation, although there seems to be some correspondence between the two variables at least during the later periods, for which we have better chronological resolution for occupation. For example, it could be argued that the stagnation in occupation during the Early Classic comes after the period with significantly diminished precipitation at the end of the Late Preclassic, with occupation rising after the return of relatively wet conditions, especially at the end of the Early Classic. Occupation continues to rise, however, despite gradually diminishing rainfall during the Late Classic periods I and II, until it drops considerably during the Terminal Classic, which does correspond roughly with a relatively abrupt and substantial decrease in rainfall. Rainfall seems to recover briefly after the Terminal Classic period, however, it decreased again at the beginning of the Early Postclassic, roughly corresponding with further decline in occupation (although here the luminescence record seems to be at odds with the oxygen and carbon isotope records, which show wetter conditions until later in the Early Postclassic, when the stable isotope records also show drastic decrease in rainfall)[18].

In Fig. 6.28b, the Peten Lakes sites' mean occupation rates, presented in Table 6.4a, are plotted against the oxygen isotope record, serving as a long-term precipitation proxy. As with the Belize Valley case above, the relationship between occupation rates and precipitation rates is not straightforward but can be argued that it shows some correspondence. There is a substantial increase in occupation in the Late Preclassic period, during a time of wet and relatively stable rainfall. The occupation rate then drops during the Early Classic after a decrease in precipitation and an abrupt event with very low rainfall indicated at AD 250. However, as in Belize Valley case, the occupation rates increases significantly during the Late Classic period, despite the gradually decreasing rainfall indicated by the Salpeten proxy, until occupation drops again after a period with considerably diminished precipitation in the second half of the Late Classic period (ca. AD 760–810). Another decrease in occupation rates comes after another spike in oxygen isotope values, indicating an abrupt and severe drop in rainfall around AD 1000.

Given the much poorer chronological resolution of occupation data in comparison to palaeoclimatic data, the comparison is only exploratory and cannot be used as clear evidence of a relationship (much less a causative relationship) between the change in occupation rates and changes in precipitation. It only serves here as an initial exploratory measure and as a tool for comparison of the different regions (especially those in northern lowlands explored below). It also serves as an initial observation, a sort of null hypothesis, which is tested further in subsequent chapters (e.g., changes in water management and agricultural strategies – Chapter 7, and possible ritual responses to drought in the Maya hieroglyphic texts – Chapter 8).

6.4.2. Northern Yucatan Peninsula

The individual regions are again explored separately, with their occupation rates compared with palaeoclimate records that are as geographically relevant as possible. For the northwest Yucatan region, an oxygen isotope record derived from the Tzabnah cave speleothem at Tecoh (Medina-Elizalde et al. 2010) is used. Tecoh is located about 30 km southeast from the modern city of Merida (Tiho), in the southeast corner of northwest Yucatan. Because this record only starts around AD 490, I used oxygen isotope records from Aguada X'caamal (Hodell et al. 2005b), located approximately 40 km from Merida, for the earlier periods (and for the sake of comparison between the two palaeoclimatic records). For the Ek Balam and Yalahau regions, I used oxygen isotope records from the Lake Punta Laguna sediment cores (Curtis et al. 1996). Punta Laguna is about 50 km southeast of the Ek Balam region and between 20–80km southwest of the Yalahau region, depending on the particular site. Although Punta Laguna is relatively close to the Yalahau region, it should be stressed that Yalahau is characterised by a rainfall anomaly, receiving almost twice as much rainfall as the rest of the north of peninsula (Isphording 1975: 244). For the Cochuah region, I used sediment density records derived from sediment cores from Lake Chichancanab (Hodell et al. 2005a), located approximately 20 km southwest from the Cochuah survey region.

[18] Akers et al. (2016: 277) state that although there are differences between stable isotopes ($\delta^{18}O$, $\delta^{13}C$) and luminescence records due to changes in stalagmite petrography, they are still significantly correlated.

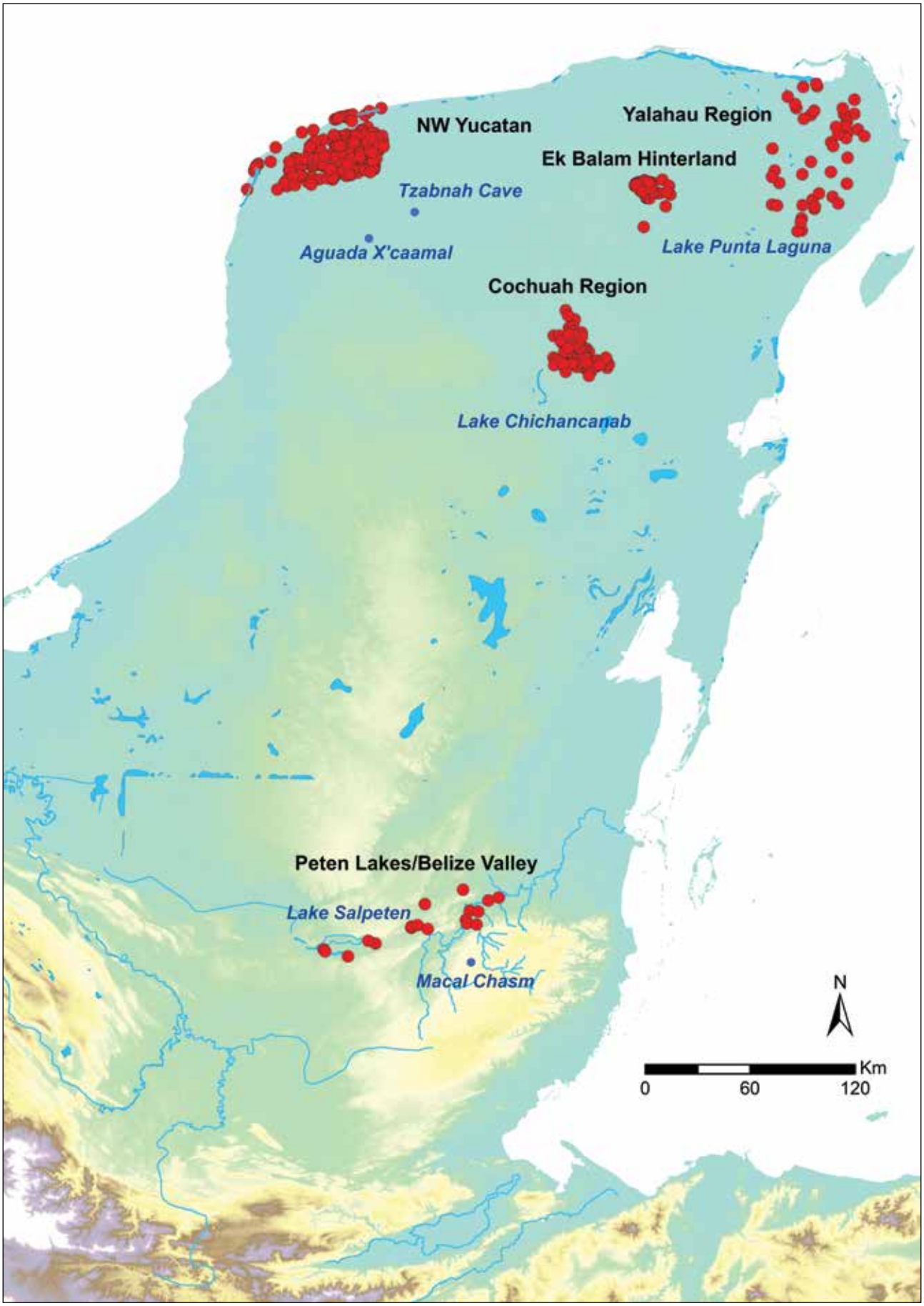


Figure 6.27. Location of individual regions and palaeoclimatic records.

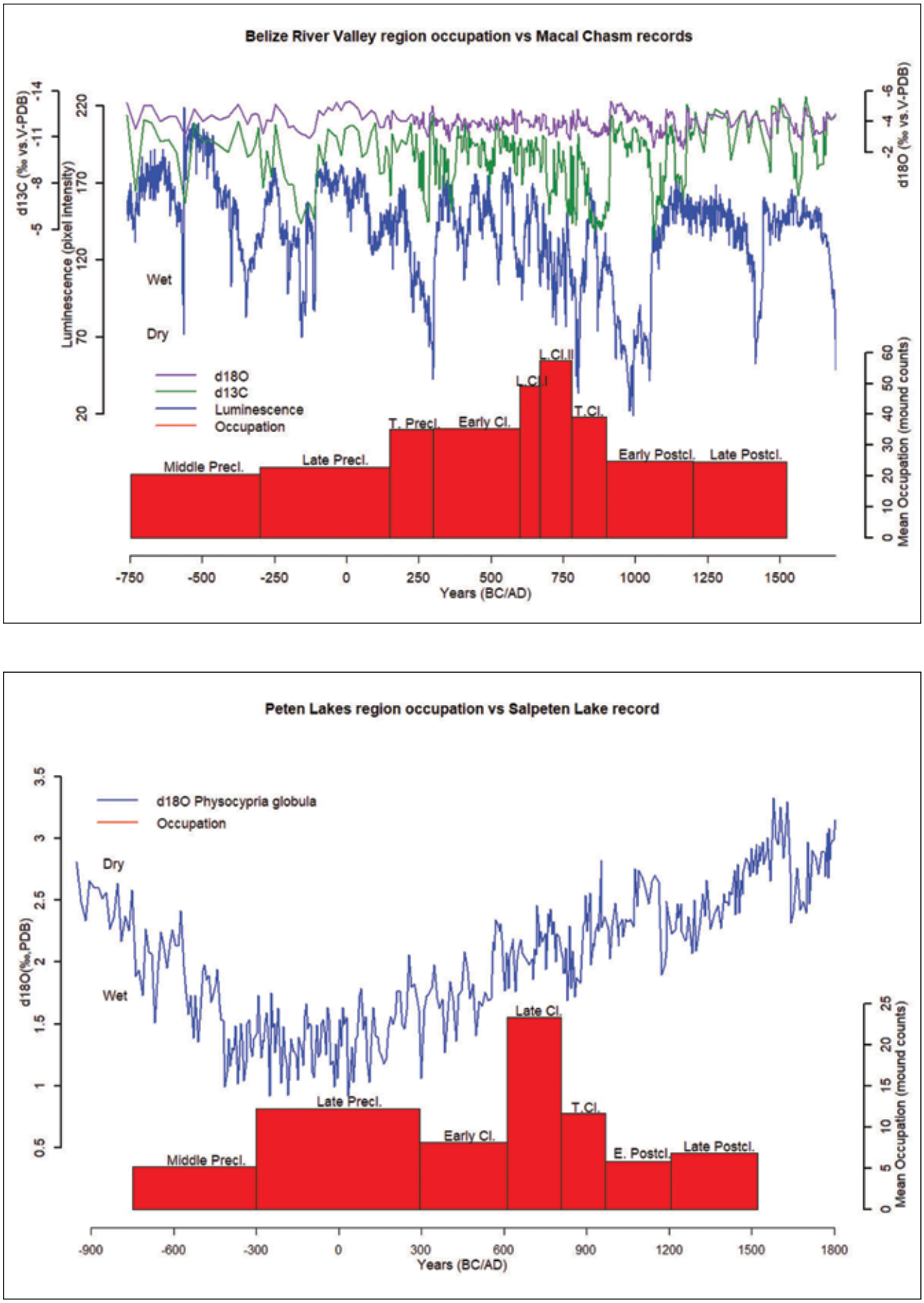


Figure 6.28. Relationship between the mean occupation and a) the luminescence and the oxygen and carbon isotopes in the Macal Chasm stalagmite record (Akers et al. 2016) in Belize River Valley and b) the Lake Salpeten oxygen isotope record (Rosenmeier et al. 2002a, 2016) in Peten Lakes region.

Northwest Yucatan

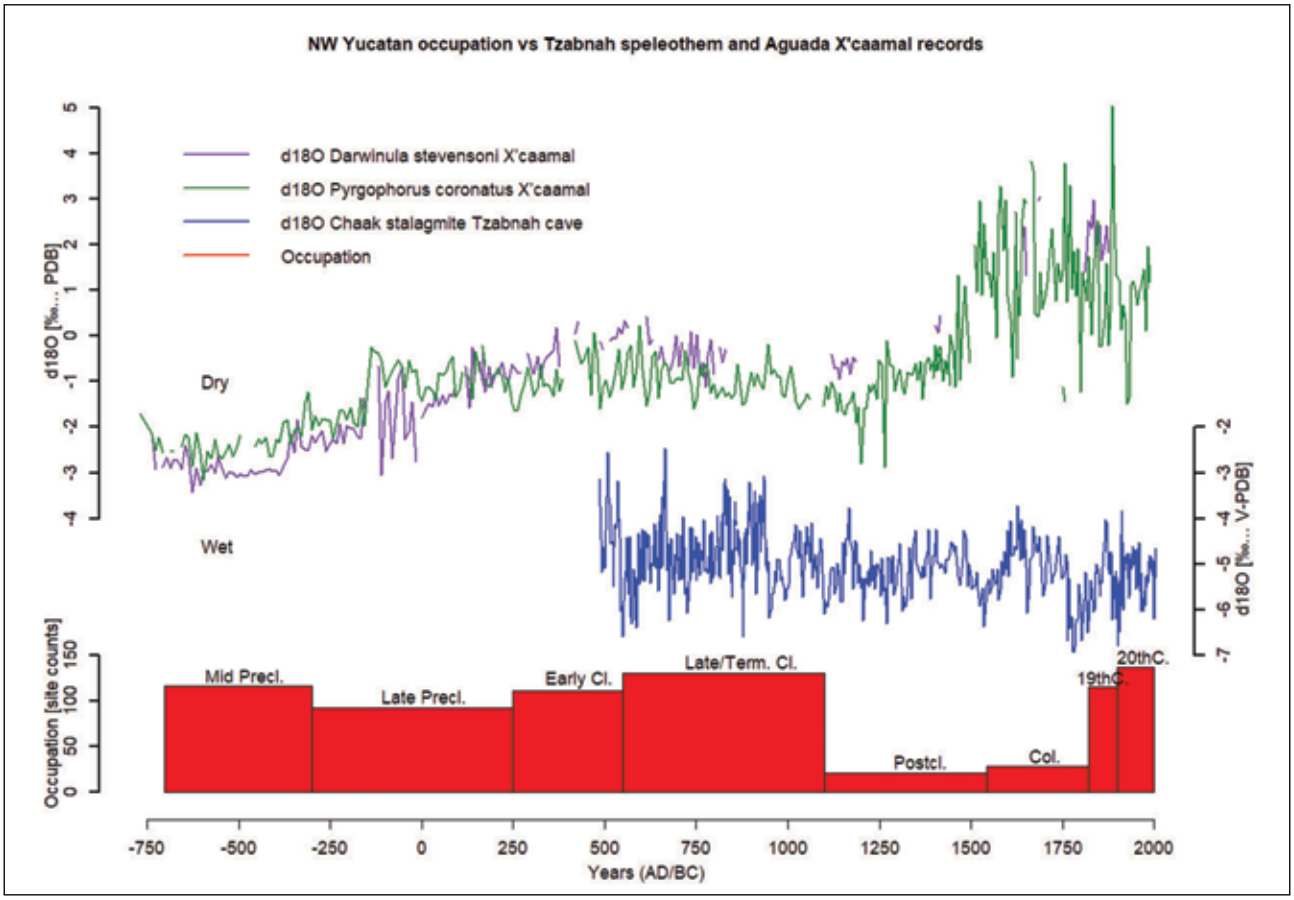


Figure 6.29. Comparison between the northwest Yucatan region occupation rates through time and rainfall proxy records derived from Aguada X'caamal (Hodell et al. 2005b) and the Tzabnah cave speleothem (Medina-Elizalde et al. 2010).

A comparison of occupation rates with the palaeoclimatic data for the northwest Yucatan region (Fig. 6.29) indicates that occupation is high during the Middle Preclassic, corresponding with a wet period shown by the Aguada X'caamal rainfall proxy. Occupation then drops during the Late Preclassic, which shows diminished and highly variable rainfall. Relatively dry conditions continued during the Early Classic period. The occupation data presented here for the Early Classic period indicate a slight increase; however, we know from other settlement data in the region that many sites experienced demographic collapse or were abandoned during the Early Classic period (e.g., Komchen and Dzibilchaltun). The Tzabnah speleothem record only starts at AD 480: it indicates low rainfall until the end of the Early Classic and corresponds with the Aguada X'caamal record. In both, the Aguada X'caamal and especially in the Tzabnah speleothem record, the Late Classic is probably best described as showing a highly variable rainfall pattern, with periods of both very low and relatively high rainfall, but drier in general, especially in the later phase of the Late Classic. The occupation rate, however, shows an increase during the late phase of the Late Classic, reaching a peak. Towards the end of the Terminal Classic, the rainfall slightly increases and, at least, the first half of the Postclassic period is indicated to be relatively wet, especially according to the Aguada X'camaal record, however, occupation rates drop considerably and stay low in comparison to Late/Terminal Classic occupation. The palaeoclimatic records differ significantly from the end of the Postclassic period onwards. Whereas the Tzabnah record shows increasing rainfall at the end of the Postclassic, the X'camaal record shows severe drought during this time and during the Colonial period (however, it has been suggested that Aguada X'caamal might have shifted from a hydrologically open to a closed system over time and its reliability as a long-term palaeoclimatic record has been questioned: Hodell et al. 2005b; Medina-Elizalde et al. 2010; Douglas et al. 2016). Occupation shows a slight increase during the Colonial period, and then increases substantially in the 19th century, after the considerable increase in rainfall at the end of the 18th century.

In general, it could be argued that some correspondence between the palaeoclimatic record and occupation data exists, at least for the Preclassic period; however, there is no obvious correlation between the relatively low and variable rainfall and the high occupation rates during the Late/Terminal Classic period, and the relationship is especially contradictory between the increased rainfall at the end of the Terminal Classic and a large drop in

occupation at the same time. Furthermore, occupation continued to be low despite the relatively wet conditions indicated by both palaeoclimatic proxies, at least during the Early Postclassic period.

Although the chronological resolution of the Ek Balam region occupation data is marginally better than that for northwest Yucatan, there is no obvious relationship between the occupation changes and variation in rainfall (Fig. 6.30). There is decreasing population with lower rainfall during the Early Classic and Middle Classic periods, but on the other hand, the peak in occupation during the Late/Terminal Classic period seems to correspond temporally with the driest period in the Punta Laguna oxygen isotope record. Moreover, there is a drop in population at the end of this dry stretch, just as the rainfall increases again.

Looking at the comparison between the Yalahau region occupation rates and the palaeoclimatic data (Fig. 6.31), we see a different situation to that of the Ek Balam region. There is an increase in occupation during the Late Preclassic/Early Classic period, corresponding with an increase in rainfall at the end of the Middle Preclassic. This is followed by a decrease in occupation during the Late/Terminal Classic periods, corresponding with the driest period indicated by the Punta Laguna records and then an increase in population in the Postclassic following the increase in precipitation at the end of the Terminal Classic period. Given the use of the same rainfall proxy for both Ek Balam and Yalahau region, it could be argued that if the occupation changes were related to variation in rainfall, we would expect the same occupation trajectory. This is not the case; therefore, it could be argued that the change in the occupation is not linked to rainfall. Comparing the occupation trends of the Ek Balam and Yalahau regions, we see that whilst the Ek Balam region is thriving during the driest period, the occupation rate in the Yalahau region dropped considerably during this time. Such an occupation trend in the Yalahau region might seem even more counterintuitive given the fact that (despite using the same rainfall proxy here), Yalahau normally receives a significantly higher rainfall than the rest of the northern peninsula. If, however, we take into account the nature of the Yalahau region, which is characterised by wetlands, it is very likely that the reduced precipitation would have had a significantly larger impact in this region than in the rest of the northern part of the peninsula, where agricultural strategies especially were adapted to lower precipitation rates. Yalahau's agricultural strategies were closely tied to wetland agriculture, which might not have been feasible with reduced rainfall (agricultural strategies and their changes are discussed in more detail in Chapter 7). Another possibility is that the changes in occupation are unrelated to precipitation and other factors have to be considered.

The situation in the Cochuah region is comparable with that of Ek Balam, showing the highest occupation rate during the driest period as indicated by the Chichancanab rainfall proxy record. In fact, the graph exploring relationship between occupation rate and rainfall (Fig. 6.32) shows little correspondence between the two variables. After highly variable rainfall, including several very dry periods during the Middle Preclassic period, corresponding with low occupation, both the amount of rainfall and the occupation rate increase during the Late Preclassic, which corresponds for the large part with higher and more stable rainfall. Occupation then decreases again considerably during the Late Classic period. The drought event that occurred during the Late Classic (~AD 670), seems to come after the drop in occupation, rather than precede it. At the end of the Late Classic period, rainfall becomes highly variable, with several very dry periods, a pattern which continues through the Terminal Classic and corresponds with the peak in occupation. As in Ek Balam's case, there is a large drop in occupation at the end of this dry stretch, and despite being followed by increased and more stable rainfall throughout the Postclassic period, occupation does not increase again until the Colonial period. One of the possible explanations of this seemingly contradictory pattern, in both the Cochuah and Ek Balam regions, is that people were able to deal with drought only for a certain period of time. There is no indication in the rainfall proxy record, however, that the increase in population during the Colonial period is in any way linked to precipitation.

6.5. Evaluation of drivers behind changes in settlement patterns

In Chapter 3, I discussed several different factors (e.g., access to water, soils suitable for agriculture, rainfall patterns, social and political organisation, concentration and dispersal of political and economic power, warfare and religion) influencing settlement patterns and the type of effect the different factors might have had on settlement location, size, organisation and distribution. Earlier in this chapter, I explored the observable changes in settlement in the case study regions through time, and below I evaluate the evidence to see if and how these changes reflect the influence of any of the proposed factors, both environmental and non-environmental.

What changes were observed in settlement patterns in the case study regions and how do they relate to the above-proposed factors?

Both the greater Belize Valley and the northern Yucatan peninsula show occupation from the Middle Preclassic period. The Late Preclassic shows an increase in occupation in both regions in general, but with some local variability. While the majority of sites in Belize Valley show increases in occupation (e.g., Baking Pot, Barton Ramie, the BRASS-covered area), the Xunantunich area shows a temporary decline during the Late Preclassic (with the exception of Actuncan, which seems to be in competition with Xunantunich throughout most of their mutual history). In the Peten Lakes area, most sites (with exception of

Ek Balam region

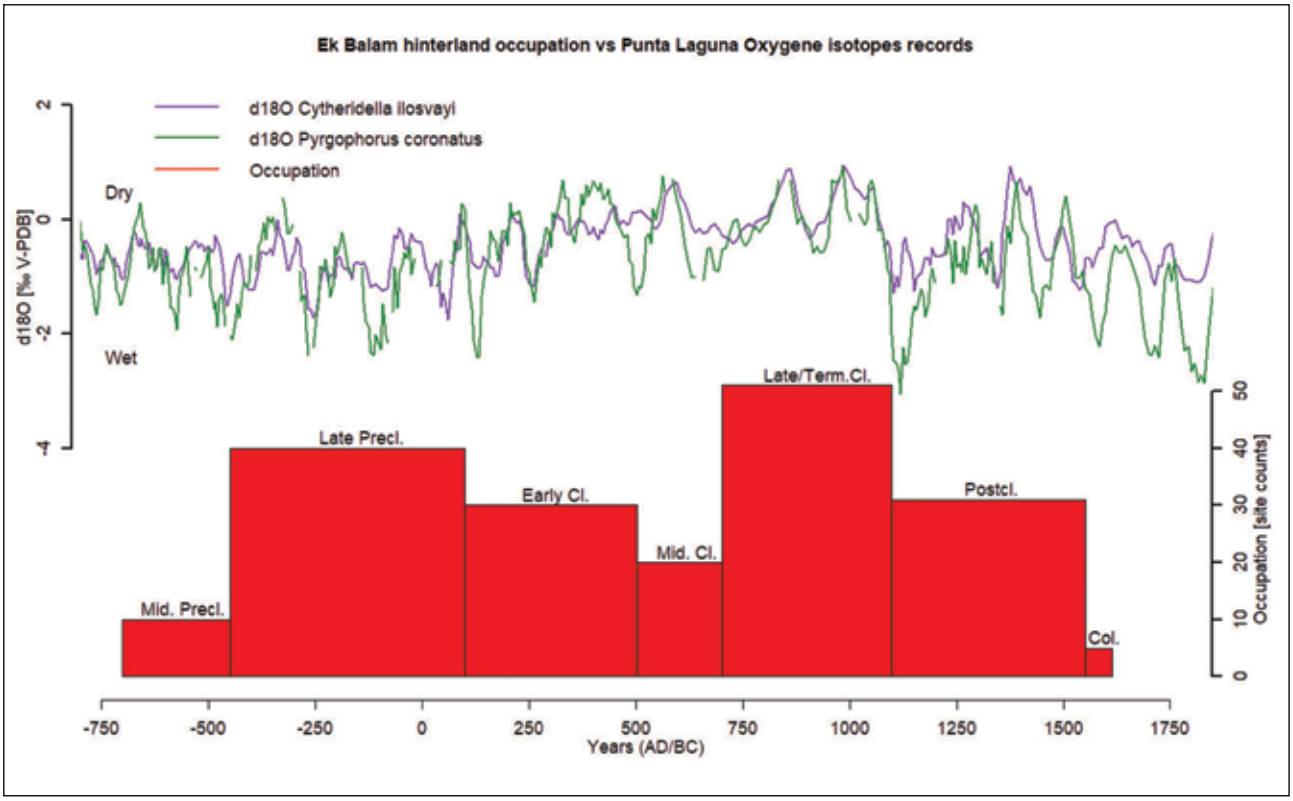


Figure 6.30. Comparison between the Ek Balam region occupation rates through time and the Punta Laguna precipitation proxy (Curtis et al. 1996).

Yalahau region

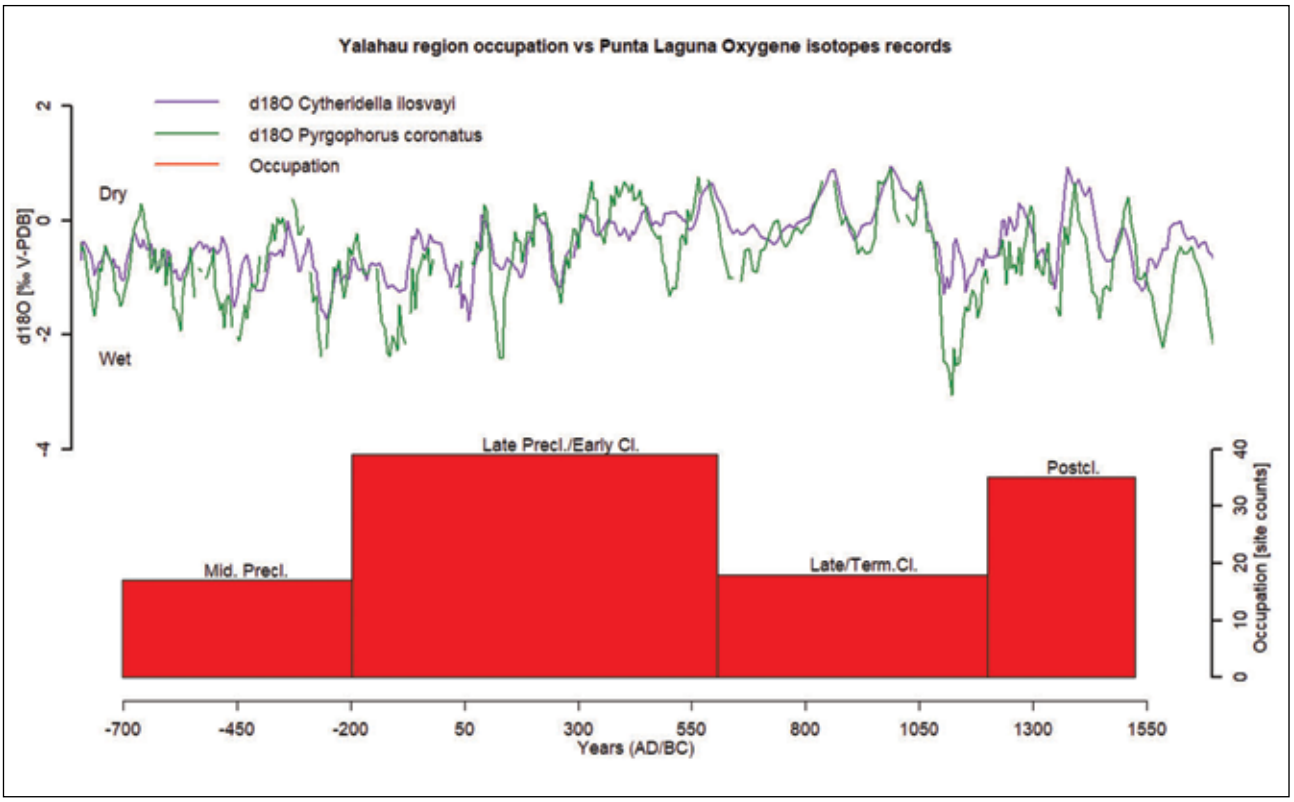


Figure 6.31. Comparison between the Yalahau region occupation rates through time and the Punta Laguna precipitation proxy.

Cochuah region

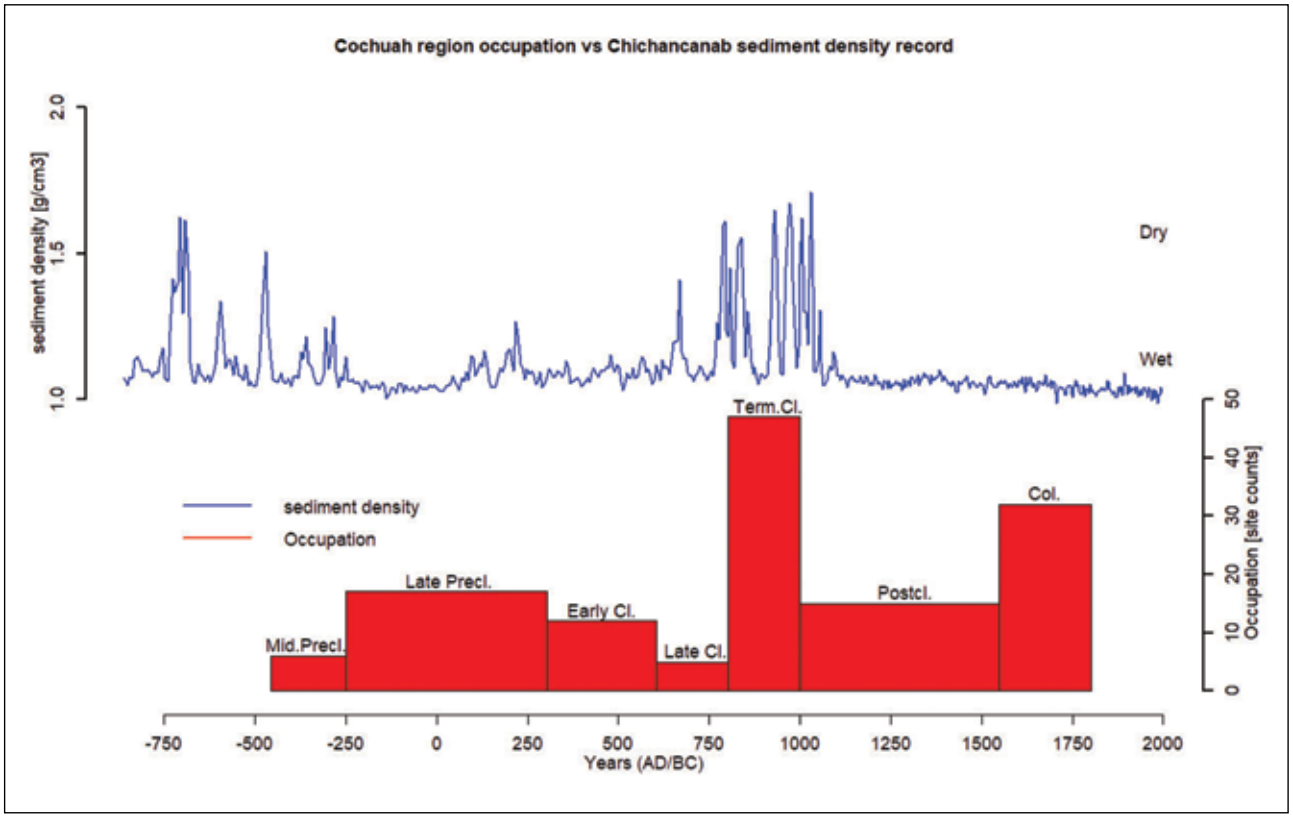


Figure 6.32. Comparison between the Cochuah region occupation rates through time and the Lake Chichancanab rainfall proxy (Hodell et al. 2005a).

Salpeten, Quexil and Cerro Ortiz) also show an increase in occupation during the Late Preclassic period. In the northern lowlands, all areas apart from northwest Yucatan, which underwent a small decline after relatively dense occupation during the Middle Preclassic, show considerable increase in occupation during the Late Preclassic period. Increase in occupation during the Middle and Late Preclassic period is accompanied by considerable construction activity. The end of the Preclassic, however, indicates considerable change. The Early Classic period shows cessation of construction activity and even abandonment of many centres in the Maya area. In both study regions, many sites experienced a decrease or at least stagnation in occupation. Barton Ramie, San Lorenzo, the BRASS area, Macanche, Quexil, Murrala de Leon, Cerro Ortiz, and Nakum in Belize Valley/ Peten Lakes all show decline. In the northern lowlands, the two inland regions, Cochuah and the Ek Balam-periphery, show a decrease of occupation during the Early Classic as well, corresponding in general with southern lowlands occupation dynamics. However, there are sites, such as Baking Pot in the Belize Valley and Yaxha, Cante Island, Sacnab, Salpeten, Zacpeten Peninsula, Petenxil and Quexil Islands in Peten Lakes, which show growth during this period. The majority of sites showing the increase in occupation during this period are located on islands and peninsulas. A similar pattern of movement to a water-rich environment appears later during the Terminal Classic and especially the Postclassic period in Peten. The Peten Lakes region experienced another growth in population during the Postclassic. Some surviving and some newly-established settlements seem to have been organised into small, densely settled and nucleated communities, usually located on islands and lake peninsulas. Such a distribution of settlements might indicate a need for access to water and natural resources. Equally likely, it can be related to intensified Postclassic trade and exchange or to political factors, such as warfare and a need for defence. In the northern lowlands, the move to water-rich environments could be reflected by the significant decline in occupation in the inland regions at the end of the Terminal Classic and the concentration and increased occupation of the coastal areas during the Postclassic period. As with the Peten Lakes region, such a settlement pattern might indicate an increased need for access to marine resources, broadening the subsistence base and reducing the risk from agricultural failure. Given the more ambiguous and variable relationship between the occupation rates and rainfall patterns in northern lowlands, it is very likely that the increased occupation of the coastal regions in the Postclassic might be related to changing trade routes and salt production-focused economies (Andrews 1993; Golitko et al. 2012; Golitko and Feinman 2015; McKillop 2002, 2005). Even these activities might theoretically be related to environmental factors, as increased trade and shifting to less agriculturally-oriented economies could reflect development of coping strategies in the face of the drying trend.

6.5.1. Distinguishing between the factors

Environmental factors

Given the poor chronological resolution of the occupation data, the comparison between occupation changes and changes in rainfall patterns on a regional scale is mostly exploratory, but it is possible to make an initial tentative observation that not only are there different rainfall patterns in different regions, but that the relationships between the occupation and rainfall vary between the regions. An important point is that whereas there seems to be some correspondence between the occupation rates and rainfall patterns in the southern lowlands, the relationship seems to be weaker and more variable in the northern lowlands in general, although the Yalahau region might be an exception. The Belize Valley and Peten Lakes regions show the stagnation/decrease in occupation after the decrease in rainfall at the end of the Late Preclassic and, in both cases, there is also a significant drop in occupation after another period with severely diminished precipitation at the end of the Late Classic. Interestingly, in both regions, occupation continued to rise in the Late Classic despite gradually decreasing rainfall. The gradual decrease, however, is very likely an important factor here, as it might have enabled an adjustment to drier conditions. Such a hypothesis might be supported by the fact that the drying trends, both during the Late Preclassic and the Late/Terminal Classic periods, are in the southern lowlands in general, and in the Belize Valley and Peten Lakes in particular, correlated with the development (Late Preclassic) and extensive use (Late Classic) of intensive agricultural techniques, especially wetland agriculture (*bajos* in Peten Lakes) and terracing (at Xunantunich), with changes in water management (Baking Pot, Nakum), and associated changes in settlement patterns (this is discussed in detail in Chapter 7). On the other hand, the declines in occupation seem to occur after considerable and relatively abrupt reductions in rainfall that would be more difficult to respond to.

The relationship is more ambiguous and sometimes contradictory in the northern lowlands regions. In the northwest Yucatan, occupation rates during the Middle Preclassic and the Late Preclassic seem to correspond with wet and dry periods respectively, indicated by palaeoclimatic proxies. Similarly, the slightly higher rainfall at the beginning of the Early Classic, but generally low rainfall until its end, might correspond with an increased occupation in the region in general, but also with the demographic collapse and abandonment of several sites in the northwest region during the Early Classic period.

On a local scale, the existence of environmental stress in the northwest Yucatan region might be supported by the shift in population concentration from the site of Komchen to the area of the cenote Xlacah near Dzibilchaltun after the Early Classic. This shift in occupation might have prompted the rise of Dzibilchaltun, which became a major centre during the Late Classic period (Cottier 1982: 216). The location of Dzibilchaltun, other than the existence of the cenote Xlacah, might have been chosen because of agricultural lands and salt resources (Cottier 1982: 216).

The relationship between occupation and rainfall in the northwest region appears more contradictory in the later periods. The higher occupation rates do not correlate with relatively low rainfall during the most of the Classic/ Terminal Classic period, and the relationship is especially contradictory between the increased rainfall at the end of the Terminal Classic and a large drop in occupation at the same time. Furthermore, occupation continued to be low despite the relatively wet conditions indicated by palaeoclimatic proxies at least during the Early Postclassic period. It is, therefore, very likely that the changes in occupation during the Late/Terminal Classic and Postclassic periods in NW Yucatan are unrelated to changing rainfall patterns and we might need to look to other factors.

The situation is even less clear in both the Cochuah and Ek Balam regions where the data indicate the highest occupation rate during the driest period in the palaeoclimatic records. In the case of the Cochuah region, the peak in occupation, in fact, occurs during the period with extreme rainfall fluctuation in the Terminal Classic period. On the other hand, settlement dispersal in the Cochuah region during the Terminal Classic period has been suggested as a possible adaptation strategy to limited water availability during this time (Shaw 2008, see Chapter 7). Therefore, although the role of environmental factors cannot be excluded, as with the northwest Yucatan region, it will be useful to look at other factors as possible stimuli in occupation changes.

The Yalahau region, on the other hand, shows a very different relationship with the same palaeoclimatic record. There is a noticeable correspondence between the occupation rates and rainfall amount, especially during the Late/Terminal Classic period. Although this discrepancy between the Ek Balam and Yalahau regions might seemingly indicate confirmation of the fact that the occupation changes in the northern lowlands are completely unrelated to changing rainfall patterns, a close exploration of the environmental conditions of the Yalahau region, and especially the subsistence patterns closely tied to wetland agriculture, suggest that in the case of the Yalahau region, a relationship between occupation and rainfall might be meaningful. It has been suggested that the abandonment of the Yalahau region during the Late Classic period might have been due to changing sea levels, possibly causing the disruption of wetland agriculture (Fedick and Morrison 2004: 213). Such a hypothesis is supported by the fact that in the wider region around Yalahau, its Classic and Early Postclassic abandonment, especially after the period of heavy occupation, represents an anomaly (Fedick and Morrison 2004). The areas to the west and south, such as the Chikinchel region or the site of Coba, witnessed growth during the Classic period and continuity of occupation through the Postclassic (Fedick and Morrison 2004; Kepecs 1998; Folan et al. 1983b; for further discussion of Yalahau region and its agricultural strategies see Chapter 7).

Given the discrepancy between the chronological resolutions of the occupation record and the palaeoclimatic data, these interpretations are tentative. While keeping that in mind, however, they serve as an initial step, a null hypothesis, which is further tested in subsequent chapters.

Socio-political factors

Not all settlement changes can be explained by environmental factors. Overemphasising the role of environmental factors has been often criticised as environmentally deterministic and many argue that settlements and their changes are a better reflection of social, political and economic organisation and activities (e.g., Willey 1956; Ashmore and Knapp 1999; Flannery 1972).

Settlement models discussed in Chapter 3 indicate that site settlement patterns and their changes often reflected the hierarchical networks these centres belonged to, which were in constant flux, depending on the interaction between the centres (Helmke and Awe 2012; Graham 2011). Within the Belize Valley region, examples of settlement changes might be indicated by the occupational history of the Xunantunich hinterlands, which, according to Yaeger, closely follows that of Xunantunich itself and is closely linked to its political standing (Yaeger 2010; Robin 1999, 2002, 2004; Neff 2010). The research at Xunantunich has shown a likely competition for the valley's resources and for political dominance between sites like Buenavista and Xunantunich. The hypothesis that Xunantunich gained the upper hand is supported not only by the general growth of occupation within Xunantunich as well as in its hinterlands, but also by apparent shift in spatial orientation of the architecture built or remodelled during the Hats' Chaak phase both at Callar Creek (Ehret 1995) and at Chaa Creek community, oriented directly towards Xunantunich (Connell 2010: 305).

In addition, the occupation history of a small community of Callar Creek, located close to Buena Vista del Cayo, might reflect commoners moving between the settlements, or what Farris (1984: 76) termed 'voting with their feet', as a result of the competition between Buenavista del Cayo and Xunantunich (Yaeger 2010: 240; Robin et al. 2010: 320). Based on the observation of movements of Maya commoners during the Colonial period, Farris argues that the ability to move around easily and settle down in new places or to integrate themselves into existing communities is one of the characteristic Maya coping strategies when dealing with unfavourable conditions (1984: 75, Graham 1994: 325). Robin and colleagues argue that movement of food producing farmers might have influenced the political balance in the area during the Late Classic (1999: 357–359; Robin et al. 2010).

A similar case of competition might be indicated in the Peten Lakes region between the Tayasal-Paxcaman zone and Yaxha-Sacnab basin. Furthermore, based on the archaeological and hieroglyphic records, the political histories of major centres in Belize Valley, such as Baking Pot, Cahal Pech and Xunantunich, are closely tied up with hierarchically higher-order centres, especially Naranjo and Caracol (Helmke and Awe 2008; Martin and Grube 2008). The smaller sites in peripheral regions were often caught up in the changing (usually adverse) relationships between the larger centres, which competed for political and economic control; hence the smaller communities fell under changing authorities (Audet 2006; Graham 2011; Helmke and Awe 2012).

In the northern lowlands, a similar situation may have existed in central Yucatan with the rise of Chichen Itza. The occupation histories of the surrounding sites seem to be closely tied to that of Chichen Itza. Increased occupation at Popola corresponds with major growth and florescence at Chichen Itza between AD 900 and 1200, when Chichen became a regional capital (Andrews and Robles Castellanos 1985: 65–66; Robles Castellanos and Andrews 1986: 83). On the other hand, the rise of Chichen Itza might have been (if only in part) responsible for the fall of both Coba and Yaxuna at the end of the Terminal Classic period. Based on the hieroglyphic evidence, Ek Balam, which became a primary centre of the north-central region, might not have fallen under the influence of Chichen Itza (Ringle et al. 2004). Instead, Ek Balam's decline might be related to competitive construction projects, which resulted in the centre being eventually outcompeted by Chichen Itza (Ringle et al. 2004: 512–514; more detailed political histories, based on archaeological and epigraphic evidence are discussed in Chapter 8).

Changes in settlement organisation, such as nucleation and dispersal are also linked to political and economic centralisation and decentralisation respectively (e.g., Sabloff 1996; Rice and Rice 1980). In contrast to the dispersed and scarce Postclassic population found in the Belize Valley region, the Peten Lakes experienced a growth in population during this phase. Some surviving and some new settlements seem to have been organised into small, densely settled and nucleated communities, usually located on islands and lake peninsulas. However, one of the major differences between the organisation of Classic and Postclassic centres in the Peten seems to be the apparent disregard for inter-structure alignment and orientation (Johnson 1985: 152). Based on observations of Postclassic settlements on the Topoxte Islands, it seems that even the ceremonial structures arranged around the plaza are far from being at right angles to each other (Bullard 1970; Johnson 1985).

In addition, the Classic period formal organisation into patio groups is less common. In this respect, the Postclassic distribution of structures, at least in the Yaxha-Sacnab basin, seems to revert to one resembling the Preclassic, with more frequent occurrence of solitary structures (Rice and Rice 1980: 451). If, as argued by Rice and Rice (1980), Late Classic formal settlement structure reflects centralised and institutionalised Late Classic society, some degree of decentralisation of Postclassic society is suggested by the less formal Postclassic settlement structure. It is, therefore, possible that the nucleation into

small communities during the Postclassic period on Peten Lakes might be, in this case, more likely related to the need for defence or a greater focus on commerce (concentration of goods to make it easier to ship and distribute) rather than an increase in socio-political complexity. As discussed in Chapter 3, land scarcity or famine among swidden farmers can lead to conflict and is often accompanied by settlement nucleation (Ringle 1985: 337–339; Vayda 1961). The possibility of such a scenario might be indicated by the increased occupation of the Peten Lakes region during the Late Classic on one hand, and significantly decreased land availability at the same time on the other (see Chapter 7, Table 2). Alternatively, if *plazuela*s are, as some but not all suggest, single house mounds that become compounds as a local family grows, then perhaps the absence of *plazuela*s, might suggest incoming people with no local longevity, or a very different sense of property/residence rights in local area (Andrew Bevan pers. comm. 2017).

Although there is no clear evidence of increased nucleation of settlement in the Belize Valley sites, Classic period settlements at Baking Pot and Barton Ramie show evidence of directional and rectilinear patterns indicating some level of centralisation/central authority and the possibility of top-down control during this time (Bevan et al. 2013). Even clearer evidence of planning and formal organisation of settlement comes from the Postclassic site of Tulum in northern Yucatan, although in Tulum's (and Mayapan's) case, this organisation has been linked to defence purposes (Coe 1961: 439). As mentioned earlier, however, it might have also been use to control the movement of goods and people. Furthermore, in the northern lowlands, extreme density of sites such as Chunchucmil and Mayapan has been seen as indicative of the existence of different political structure, and possibly related to the growth of mercantilism (Sabloff 1996).

Mayapan has been seen as a centre of a Postclassic Maya hegemonic empire, which was governed by 'joint rule' or *multepal* form of government (involving multiple rulers or a confederacy, Schele and Freidel 1990, but this has been doubted more recently, e.g., Boot 2007; Cobos 2000, 2007). A similar form of rulership was suggested by Jones (1998: 105–106) for the Itza Polity in the Peten Lakes, where he argues, rulership was shared by principal and subsidiary lords through a council, but 'tempered by a strong principle of lineage domination by a single group of closely related males'. Interestingly, based on his more recent survey of Mayapan, Russell (2008: 669) describes its settlement being distributed around 'dual-foci'; with the important ritual and administrative functions possibly divided between, or independently existing at, what became the main site centre during the Postclassic period next to Cenote Ch'en Mul, and at the earlier Terminal Classic ceremonial centre known as Itzmal Ch'en group. Both centres seemed to have maintained 'both a population and, presumably, an independent subset of political and administrative functions' during the Posctclassic period (Russell 2008: 669).

7

Agricultural Strategies and Water Management

7.1. Introduction

In the previous two chapters I explored changes in climate and settlement patterns respectively. We can already draw out some of the wider implications of these observations. Too often however, in studies dealing with similar subjects, we see generalisations and interpretations based on the old fallacy that correlation implies causation, that the impression of similar behaviour over time in two variables (often just informally observed) means they can automatically be viewed as part of a cause-effect relationship. This approach is usually coupled with a focus on a single specific cause, such as drought, deforestation or warfare. What these studies are missing is an exploration of relationships between the individual elements and how are these related to one another in a wider context. In this chapter, I therefore further explore the relationship between environmental changes and Maya society by focusing on the variation in agricultural and water management strategies through time and on how this variation is linked to settlement and socio-political changes.

7.2. Agricultural and water management strategies – Belize Valley/Peten Lakes

7.2.1. Belize Valley

The Belize River Valley region is known for its fertile floodplains and rich agricultural soils. Unsurprisingly, the ancient Maya settlements distributed along the river closely follow these alluvial soils and the intensive settlement is highly correlated with soil fertility (e.g., Fedick 1995). Evidence of agricultural intensification and increasingly complex water management strategies is present in a few different forms. For example, intensive urban gardening (Ball and Kelsay 1992), including a grid-like distribution of house-plots, outlined by routes or paths, was detected both within and beyond the monumental core of the Classic Maya sites of Baking Pot and Barton Ramie (Bevan et al. 2013). In addition, ditched field systems in the Belize River Valley were reported first by Kirke (1980: 283) and later confirmed by settlement survey in Baking Pot (Hoggarth et al. 2008; Fig. 6.1). Bifacial choppers found during test excavations in the ditches of the Bedran settlement cluster southwest of Baking Pot were associated with agricultural activity (e.g., Harrison and Fry 2000). Fragments of obsidian blades and Spanish Lookout ceramics date the ditched fields to the Late and Terminal Classic periods (Conlon et al. 2004: 79).

The system of these ditches or lattices was explored again recently using airborne LiDAR (see Chase et al. 2014), results of which showed how extensive the system was. Approximately 23.5 km of ditches have been recorded (Ebert et al. 2015). The area where the ditch system is located is flat, swampy and prone to flooding during the rainy season. Based on the latest investigation, including ground-truthing (verifying features found on satellite and other imagery), Ebert and colleagues (2016) suggest that the ditch system was most likely used to drain the area in order to increase the land available for settlement, and/or to improve the conditions of the soils making them more suitable for farming or as house lot gardens. This would have been especially useful in the Classic period during which time the Baking Pot settlement expanded to the east, west and south from the epicentre, possibly into less desirable areas (Hoggarth et al. 2008; Jobbová 2009; Ebert et al. 2016).

Ebert and colleagues (2016) further suggest that the construction and maintenance of the system may have been organised communally. However, the alignment of the Bedran field system is noticeably similar to the alignments of the Baking Pot housemounds (Fig. 1; Kirke 1980; Conlon and Powis 2004), and replication of artefact assemblages and architecture between the Bedran Group and the Baking Pot monumental group B provides clear links between them (Conlon et al. 1994: 254; Helmke and Awe 2008b: 88–90). It is possible that this field system was a centralised capital investment, developed to provide agricultural surpluses for the site of Baking Pot. Although some underlying factors, such as aligning of houses parallel or perpendicular with the Belize River to improve drainage, should not be ruled out completely, it is very likely that some level of planning was involved (Bevan et al. 2013). Extensive terracing at Caracol according to Chase and Chase (1996: 808) also shows a 'regularity in both their alignment and organisation that can only be accounted for by centralized, administrative control' (however, see the case of Chan terracing below and also examples from Asia (and worldwide), where low-level organisation of terraced landscapes is common, e.g., Lansing 1991, Netting 1993, Pérez Rodríguez 2008).

Other evidence for agricultural terracing in the Belize River Valley comes from the recently (2013) discovered site of Lower Barton Creek. It consists of 11.4 km of terracing and adds to the ample evidence of these intensive agricultural features within the Belize Valley, supporting the hypothesis of the region's wealth and importance stemming from access to the rich agricultural soils (Awe et al. 2015).

An additional part of a wider water management system within the Baking Pot palace complex is visible in the courtyard of Group B, where there is a complex drainage system that directed water from beneath a stairway and

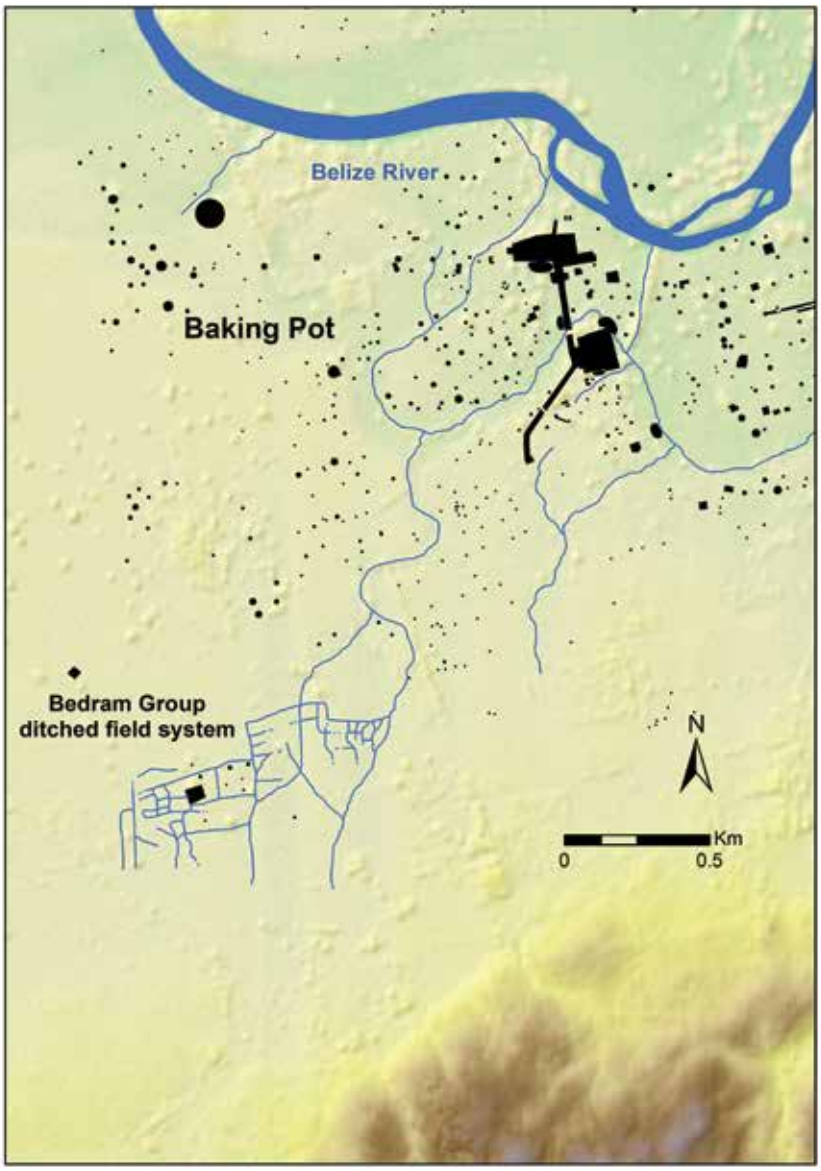


Figure 7.1. Ditched field system at the Maya site of Baking Pot.

upper room into the streams leading to *aguadas* (Audet 2005). Ebert and colleagues (2016) suggest that these *aguadas*, adjacent to the monumental groups, might, in fact, hint at the importance of water and water management to the Baking Pot rulers during the Classic period. A text found on the outside of a cacao drinking vessel from the Bedran group (where the system of ditches is located) includes a placename (emblem glyph) for Baking Pot, which has been tentatively translated as '*Chan te' ha*,' or 'four water place' (Helmke and Awe 2008b). The four *aguadas* located around the monumental epicentre might support the reading (Ebert et al. 2016). They also suggest that 'water management at Baking Pot became increasingly important during the Late Classic Period (AD 600–900) in the face of population increase, anthropogenic degradation of the landscape, and climate change' Ebert et al. (2016: 10).

In the western part of the Belize Valley, the environment is hilly, providing a perfect opportunity for the construction of agricultural terracing. Extensive terraces are documented, for example, around the Maya sites of Xunantunich and Chan, and the density of terracing in this region is one of the highest documented anywhere in the Maya area (Neff 2008; Wyatt 2005, 2008). At Xunantunich, the earliest terracing was dated to the Early Classic, but the majority dates to the Late Classic period, according to Neff (2008) this was necessitated by the rising population and accompanying demand for food. Archaeological survey and excavation of Xunantunich's hinterland resulted in the reconstruction of likely population densities and these suggest an increase during the Late/Terminal Classic period (Samal (AD 600–670, Hats' Chaak (AD 670–780) and Tsak' phases (AD 780–890)), corresponding with development and intensive use of terracing, especially during the Hats' Chaak period (Neff 2008: 114). Based on Neff's study of agricultural intensification, starting with the Samal period, there is an evidence for shortage of desirable land for either the settlement or for farming purposes. Neff further argues that during the following Hat's Chaak phase, the only available land was on hilly terrain between

Table 7.1. Occupation rates in Xunantunich-Chan area through time (from Ehret 1995)

Cultural Periods	Dates	Residential groups [n]	Residential groups [%]	Change between periods
Middle Preclassic (Nohol)	800–300 BC	7	21.2	
Late Precl./Protoclassic (Ok'inal/Pek'kat)	300 BC–AD 300	4/4	12.1	–43 %
Early Classic (Ak'ab)	AD 300–600	10	30.3	**150%**
Late Classic (Samal/Hats' Chaak)	AD 600–780	19/26	57.6/78.8	**90/36%**
Terminal Classic (Tsak')	AD 780–890	7	21.2	–73.1%
Postclassic	AD 890–1500	0	0.00	–100%
Colonial	AD 1500–	0	0.00	

the rivers and this is where the extensive terracing appears during this phase. Terracing enabled the intensification of farming and a further population increase (2008: 115). In addition, Neff analysed sealed agricultural terrace soils and assessed the level of phosphorus (P), which according to previous studies (e.g., Arnason et al. 1982, Coultas et al. 1993 cited in Neff 2008: 288–290) is a key limiting factor in local soil fertility. Based on the results of the analysis, he argues (2008: 310) that soil infertility, caused mostly by the lengthening of cultivation and continuous use of soils and resultant diminished crop yields, 'played a role in the demographic collapse that occurred in the Xunantunich area during the Tsak' phase (AD 780–890)'. Similar results were also reported by Healy and colleagues (1983), based on their research of the agricultural terraces at Caracol.

In contrast, a study focused on the agricultural terracing in the Chan area, a small Maya farming village located about 4 km southeast from Xunantunich, presents slightly different picture. Based on considerable fieldwork in the area: the village was continuously occupied from the Middle Preclassic until the Early Postclassic period (900 BC–AD 1200), with a peak in population during the latter part of the Late Classic period (AD 670–780, Robin 1999). The survey of the site and its vicinity yielded the greatest known concentration of terraces in the Belize River Valley (304 km^2; Wyat 2005: 6).

The most intensive land use and the highest density of agricultural terracing during the latter part of the Late Classic period (AD 670–780) seems to correspond with an architectural florescence and peak in population at nearby Xunantunich (Robin 1999; Wyatt 2005, 2008). Therefore, it was suggested that Chan functioned as agricultural production centre (Robin 1996, Wyatt 2008: 10). However, based on stratigraphic and ceramic evidence, the earliest use of terraces at the Chan site dates to the later part of Late Preclassic and Early Classic periods (Wyatt 2005: 2; elsewhere the date given is Middle to Late Preclassic (650 BC–AD 150; Wyatt 2009: 7), so well before the population maximum at Chan (or Xunantunich). According to Wyatt (2005: 21), such chronology indicates that the development of the terracing in Chan area was not motivated by population pressure and, therefore, does not fit with Boserup's theory of law of least effort (1965: 28). Given the evidence that the earliest agricultural terraces seem to generally date to the Late Preclassic/Early Classic period (~AD 250; Beach et al. 2002), it is perfectly possible that, at least in some areas, the adoption of these features might have been motivated by increasing problems with deforestation and soil erosion resulting from the extensive slash-and-burn farming (e.g., Turner 1983; Beach and Dunning 1995, 1997; Beach et al. 2002, 2006), rather than a population explosion. In the case of the Chan area, however, even if rising population was not an initial impulse, it should not be completely disregarded as a factor. Although both Chan and Xunantunich reached their population maximum during the Samal/Hat's Chaak period (AD 600–780), if we examine the occupation changes in the Xunantunich area more closely, there is clearly a significant increase in population already during the Early Classic or Ak'ab phase (AD 300–600; Table 7.1).

Given the proposed view that Chan functioned as agricultural centre (Robin 1996; Wyatt 2005) and considering the evidence for multiple terrace construction episodes (Wyatt 2005), it is possible that the development of the Chan terraced landscape is at least partially related to the rising population at Xunantunich and other larger centres in the vicinity, such as Buenavista del Cayo, which also experienced a boom during this period (AD 300–600; Peuramaki-Brown 2012: 325). Wyatt even mentions the possibility that the creation of terraces might be related to the increased food production needs of nearby sites, such as Xunantunich, but maintains the conclusion that 'terraces were being constructed prior to the Late Classic population explosion, contrary to accepted theories of agricultural intensification' (Wyatt 2005: 21). Furthermore, based on the hypothesis that the construction and maintenance of the Chan terraces were controlled by the local households, he argues that the Chan farmers were not under the direct influence of Xunantunich (Wyatt 2008: 11). He suggests, instead, that in fact it might have been the 'ingenuity and adaptability' of Chan farmers that 'created conditions leading to the rise of Xunantunich as a polity capital' (Wyatt 2008: 11).

Within the agricultural terracing at Chan, a relatively extensive and complex water management system is integrated. This includes a structure with multiple phases of construction (it was abandoned by the end of Terminal Classic around AD 900), associated with the terraces and adjacent to a natural spring that was used for the irrigation

of terrace beds next to the structure. The water from the spring was also directed to run inside the structure where it was collected in a small basin and perhaps used for drinking and/or to keep the temperature uniform to store food (Wyatt 2005, 2009). Another water distribution system consisted of a ditch with a pile of stones in the centre of it, which most likely functioned as a check dam, blocking the water flow and distributing it over the terrace bed. The ditch was most likely fed from the series of three *aguadas* found further up the hill, and as Wyatt (2009) suggested, water from these reservoirs might have been used for irrigation during the dry season.

According to Wyatt (2005), the system is 'the first evidence of small-scale irrigation of agricultural terraces in the Maya Lowlands' (2005: 18). Besides these water management features, the site contains numerous *aguadas*, mostly of smaller sizes, distributed throughout the site, which according to Wyatt (2009) indicates that these were controlled and maintained by local household groups rather than centrally by elites (similarly to terraces and water management features). Wyatt admits that the dating of water management features is difficult, but he places the beginning of construction of both terrace walls and the springhouse into the Middle to Late Preclassic (650 BC–AD 150), with their continuous use and maintenance throughout the site's history (Wyatt 2009: 7) and suggests that the water management features were probably not built much later (Wyatt 2009).

7.2.2. Peten Lakes region

Within the Peten Lakes region, extensive areas of fertile rendzina soils are found and correspond with dense Late Classic settlement, as well as the presence of *bajos* in the vicinity of Lake Yaxha and Lake Sacnab basins (Sanders 1977; Rice and Rice 1990: 133). Evidence for terracing is very limited in this region, although Rice has suggested that this might be partly due to difficult survey conditions (1993). Instead, in the Peten Lakes region, suggested evidence for agricultural intensification is based on the changing household to land ratio through time (Rice and Rice 1990). The results of the Rice and Rice study show that the amount of available land per household declined dramatically between the Early and Late Classic period (Rice and Rice 1990; Baker 2007: 81–82; Table 7.2).

Table 7.2. Hectares per household in the Peten Lakes Region (data from Rice and Rice 1990, cited in Baker 2007)

Temporal Period	Ha per Household
Terminal Classic	11.76
Late Classic	2.05
Early Classic	8.13
Late Preclassic	9.71
Middle Preclassic	10.52

Table 7.3. Housemound-land ratio in the Late Classic Maya Lowlands (modified from Rice and Culbert 1990, in Baker 2007: 67)

Site Name	Land (in ha) per Housemound
Seibal	0.69
Tikal (central 120 km^2)	0.89
Tikal (rural)	2.56
Becan (rural)	1.25
Macanche-Salpeten Basin	1.47
Petenxil-Quexil Basin	2.56
Yaxha-Sacnab	1.69
Belize Valley	0.84
Belize Valley (Fedick 1996:121)	1.61
Uaxactun	3.12
Nohmul	8.33
Baking Pot (Bevan et al. 2013) (L/T Classic)	0.6

The data in the table only indicate a slow gradual decrease in land availability per household between the Middle Preclassic and Early Classic Period, after that, however, the amount of available land drops significantly. When these numbers, especially the land available during the Late Classic (Table 7.3), are compared to the land available to individual families in the 20th century (Table 7.4), it becomes obvious that the agricultural practices used during the Late Classic period had to be more intensive than those used by the 20th century farmers (Baker 2007: 69). Given the fact that the Late Classic period numbers include land occupied by house, kitchen gardens, roads and plazas, the difference in the data is even more significant.

Table 7.4. Amount of land used by 20th century Maya farmers (after Baker 2007: 67)

Source	Area cultivated per year (ha)	Length of fallow	Total area (ha) used in agricultural cycle
Cowgill 1961	3.4–5.0	5–12 years	23.8–35.0
Steggerda 1941	4.58	10 years	24.08–47.52
Kempton (in Cowgil 1961)	1.7–3.4	8–18 years	8.5–68.0
Atran 1993	1.28–3.6	4–7 years	6.4–32.4
Reina 1967	2.14–3.21	6 years	17.12–25.68
Wilk 1991	2.15–3.14	15+ years	32.25–66.5
Carter 1969	2.8	2–6 years (ave: 3, 4 yrs)	28–56

This disproportion indicates that with little more than two hectares of land available to the Late Classic farmers, it is very unlikely that they only used slash-and-burn agriculture (Baker 2007: 69).

In this respect, the use of wetland agriculture, and more specifically, use of *bajos* for intensive agriculture was suggested and investigated (e.g., Culbert 1996; Kunen et al. 2000). Based on the evidence that the edges of *bajos* were often occupied, it was suggested that *bajos* might have been used for agriculture, especially for planting during the dry season (Adams 1980; Gliessman et al. 1983; Culbert 1996). These areas have been called 'bajo communities' (Culbert 1996). In the Peten Lakes region, examples of such communities have been found in the Bajo la Justa, a large seasonal wetland (150 km^2), on each edge of which are located the sites of Yaxha and Nakum (Culbert 1996; Kunen et al. 2000). On the ridges and natural rises within the *bajo*, sites such as Poza Maya and Cara Fea and six other smaller settlements ('Islands') were discovered. In addition, there is an evidence of canals being cut into the *bajo*, purposely modifying it and perhaps associated with agriculture (Kunen et al. 2000).

Poza Maya (Fig. 7.2) is a medium-size site, the centre of which consists of approximately 40 structures, some of them up to 20 m in height with vaulted architecture. It is suggested that Poza Maya functioned as an administrative centre, controlling the use of *bajo* resources. Based on excavations, the settlement in the vicinity of the site's centre was only occupied during the Early Classic period, but the groups further away in the periphery were occupied from the Late Preclassic until and into the Terminal Classic period (Kunen et al. 2000). South of the Poza Maya is Aguada Maya, a natural depression, which was later modified and converted into a rectangular reservoir (Akpinar-Ferrand and Dunning 2011: 120). It is one of the largest known modified *aguada*s in the Maya Lowlands, with a catchment volume of 13,200m^3 (Weller 2006: 34). Based on the 'potential drainage canals', it is suggested that the reservoir was used for agricultural purposes (Akpinar-Ferrand and Dunning 2011: 120, Dunning et al. 2002, 2006).

Cara Fea and the 'Islands' seem to consist of smaller, mostly residential structures and occupation on Cara Fea dates mainly to the Late Preclassic and the Late Classic periods, with unclear Early Classic and nonexistent Terminal Classic occupation (from the 'Islands' only Island 6 was excavated and due to its proximity to Poza Maya, it is considered to be its hinterland area; Kunen et al. 2000). While these *bajo* communities vary considerably in terms of size and length of occupation, their occupation histories indicate that these were not short, temporary settlements. More importantly, Kunen and colleagues (2000) argue that based on the chronology of their occupation, it is clear that these communities did not originate, as it is often argued, from the population pressure during the Late Classic period and necessity to use marginal environments. The

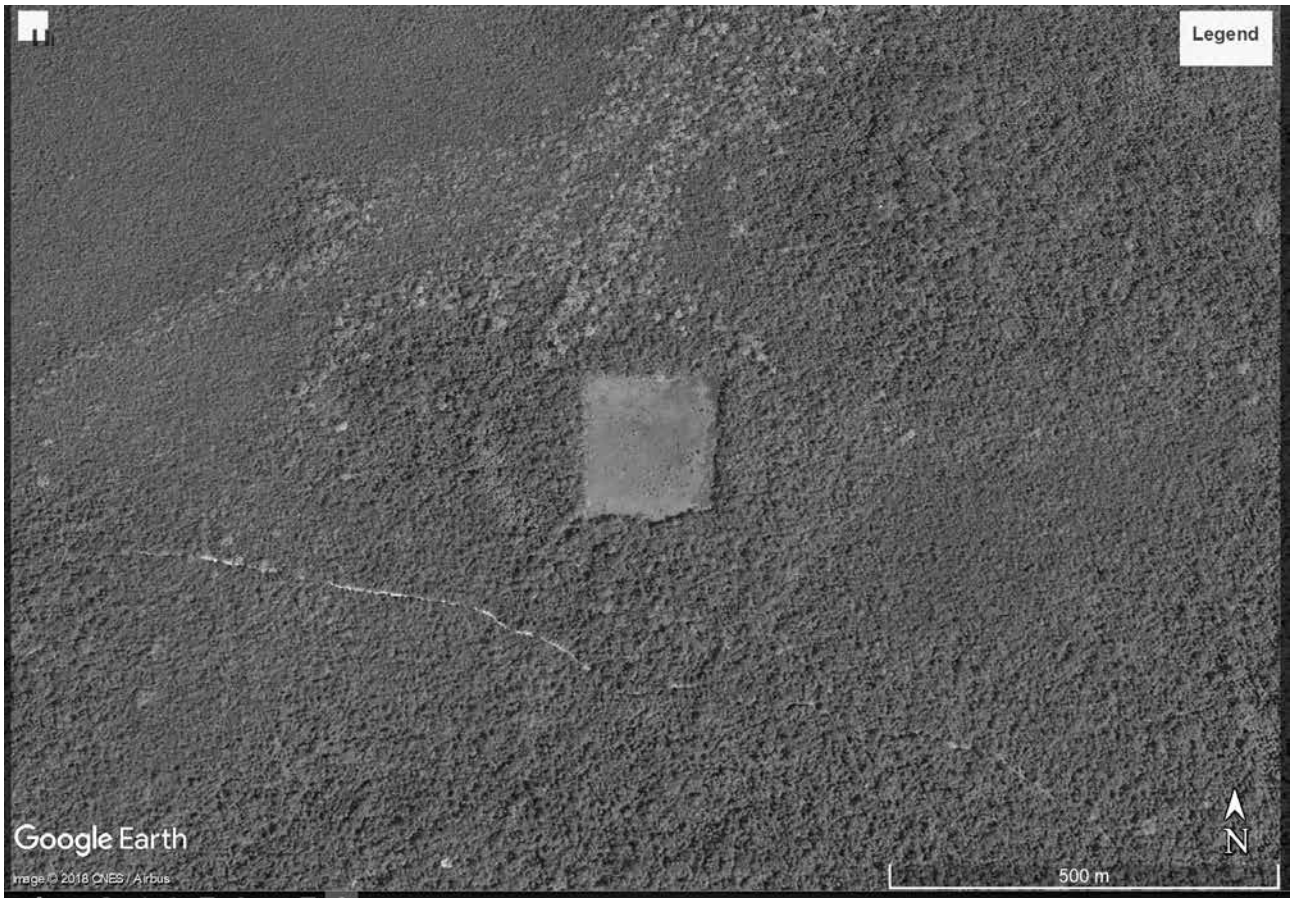


Figure 7.2. Google Earth Image of Aguada Maya.

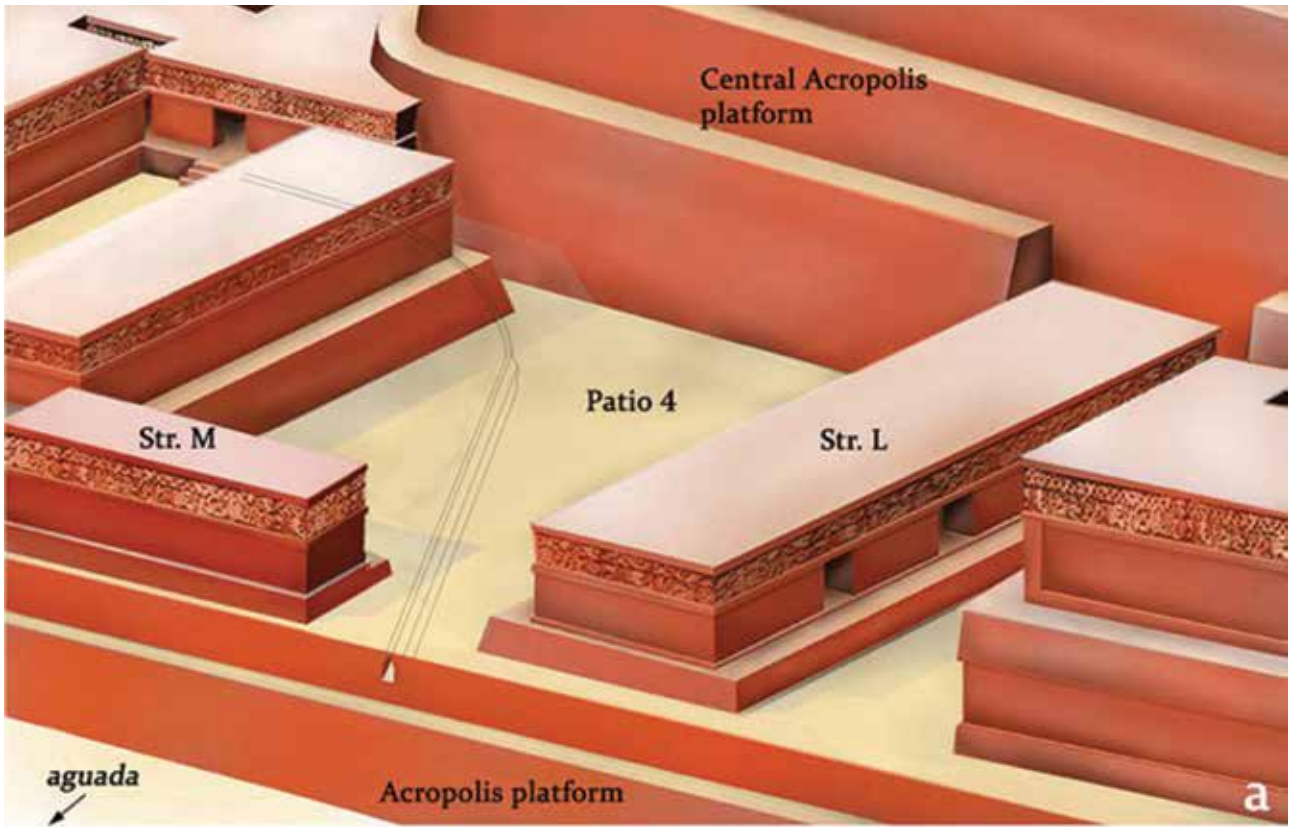


Figure 7.3. a) Reconstruction of a subterranean canal discharging water close to the *aguada* in Nakum (reproduced with permission from Źrałka and Koszkul 2015, Fig. 13).

occupation of *bajos* starts much earlier, in some cases by the Late Preclassic, and extends into the Terminal Classic period. The chronology indicates that the use of *bajos* played an important role in subsistence strategies from early on and continued to be utilised throughout a large part of Maya history (Kunen et al. 2000).

In terms of water sources, people in the Peten Lakes would have had easier access to water than many other regions, given the proximity of the lakes. That being said, it should be remembered that water sources, such as rivers, lakes, *aguadas* or wells, would only have been usable for drinking, cooking and washing and not for agriculture, unless some irrigation systems were also in place (such as the above suggested Aguada Maya), i.e., *milpa* farmers around the lakes would still have had to rely mostly on rainfall. In the interviews conducted in the present-day Maya communities (Downey and Jobbová 2011), all of the farmers said that although they sometimes water their gardens by hand using water from the river, pot irrigation is never used for larger fields because it is too laborious and inefficient. Furthermore, as in the Belize River Valley, despite the easy access to water, there is still evidence of complex water management in Peten Lakes region.

A sophisticated drainage system was found at the site of Yaxha, located on a ridge on the northern shore of Lake Yaxha (Hermes and Ramos 2004). This drainage system is connected to a causeway (Calzada Blom) and, according to Hermes and Ramos, it had been developed during four different construction phases from the Late Preclassic to the Terminal Classic period (2004: 608). Construction of the causeway started during the Late Preclassic period and later, in the Late Classic, two lateral walls were added at the eastern and western edges of the causeway. During the Terminal Classic, the causeway was modified by sloping its surface to the east and by the installation of 12 narrow canals in its eastern wall (Hermes and Ramos 2004: 609–610). These canals, according to Hermes and Ramos (2004: 610), would both prevent the causeway surface from flooding and enable run off and collection of water by two *aguada*s, which bordered the eastern edge of the causeway.

Another elaborate and sophisticated drainage system, consisting of three completely different drains, was discovered at the site of Nakum, located in the Holmul river basin about 18 km from the Peten Lakes region[19] (Zrałka and Koszkul 2015). The most complex of the drains, located in Structure 14, dates to the Early Classic period (ca. 3rd–6th century AD) and, according to investigators, probably had both a ritual and utilitarian function. It was used for some time during the Early Classic, and then partially destroyed and covered by another structure in the Late Classic period (but possibly still remained functional beneath the structure and fed an *aguada* or another reservoir; Fig. 7.3). Zrałka and Koszkul (2015) argue that it is too elaborate and unnecessarily complicated to be

[19] Although Nakum is not situated in Peten Lakes region, it is part of Yaxha-Nakum-Naranjo triangle (which are all important sites in the political history context of the region).

only used to drain water. They suggest that it symbolised a sacred mountain and might have been used during the rituals and ceremonies, showing the Nakum rulers as 'lords of water and rainmakers', associated with fertility and sustenance and, in such a way, it perhaps helped to attract and control the local population (Zrałka and Koszkul 2015: 414).

There are another two utilitarian drains at the site, both dating to either the Late or Terminal Classic period (ca. 8th–9th century AD). One of them is a functional, well-built stucco lined canal in the western part of the acropolis complex, draining its largest courtyard and feeding an *aguada.* The importance of the *aguada*, according to investigators, is indicated by the heavy construction activity evident along the eastern side of the *aguada*, including a shrine that might have been used 'during rituals of a water cult' (Zrałka and Koszkul 2015: 410). The second, much smaller drain, constructed from ceramic tubes and located in the western part of the acropolis, drained water from the highest platform terrace, possibly to the *aguada* as well (Zrałka and Koszkul 2015).

7.3. Agricultural and water management strategies – The Northern Yucatan Peninsula

'*Yucatán is the country with less earth that I have ever seen, since all of it is one living rock' (Diego de Landa in Tozzer 1941: 1981).*

Our understanding of subsistence strategies in the northern lowlands is still lagging behind that of the southern lowlands. The region is unfavourable for agriculture (at least in comparison to the southern lowlands), with poor soils and low precipitation (Figs. 7.4 and 7.5). Furthermore, the lack of permanent swamps and mostly very flat terrain prevents the use of raised fields, drained fields or terracing as strategies for agricultural intensification (the strategies discussed above for the southern lowlands; Morrison 2006: 44). The density of occupation indicates, however, that some sort of intensification must have occurred in order to sustain the population. In order to maintain at least a rough correspondence with regional divisions used in the settlement chapter, the northern lowlands will again be divided in to three sub-regions: the northwest karst plain, the northeast karst plain and northeastern Yucatan (specifically the Yalahau, Coba-Okop region and Quintana Roo depression, following the regions of the Maya lowlands as defined by Dunning 1998, see Fig. 2.6 in Chapter 2).

7.3.1. Northwestern Yucatan (northwest karst plain)

The northwest karst plain is the driest and the most inhospitable region of the northern Maya lowlands (Andrews and Robles Castellanos 2008: 3). The average temperature range is 24–28 °C and precipitation 600–800 mm (Poag 2015: 19). The low amount of precipitation also means very shallow and poor soils, as precipitation is needed to break down the bedrock and support vegetation (Wilson 1980: 33). The shallow soil, only a few centimetres deep, is low in nutrients and incapable of retaining moisture during the dry season, therefore creating limitations for agriculture (Beach 1998b; Dahlin et al. 2005). The farming here was limited during historic times too, when the region relied on cattle and

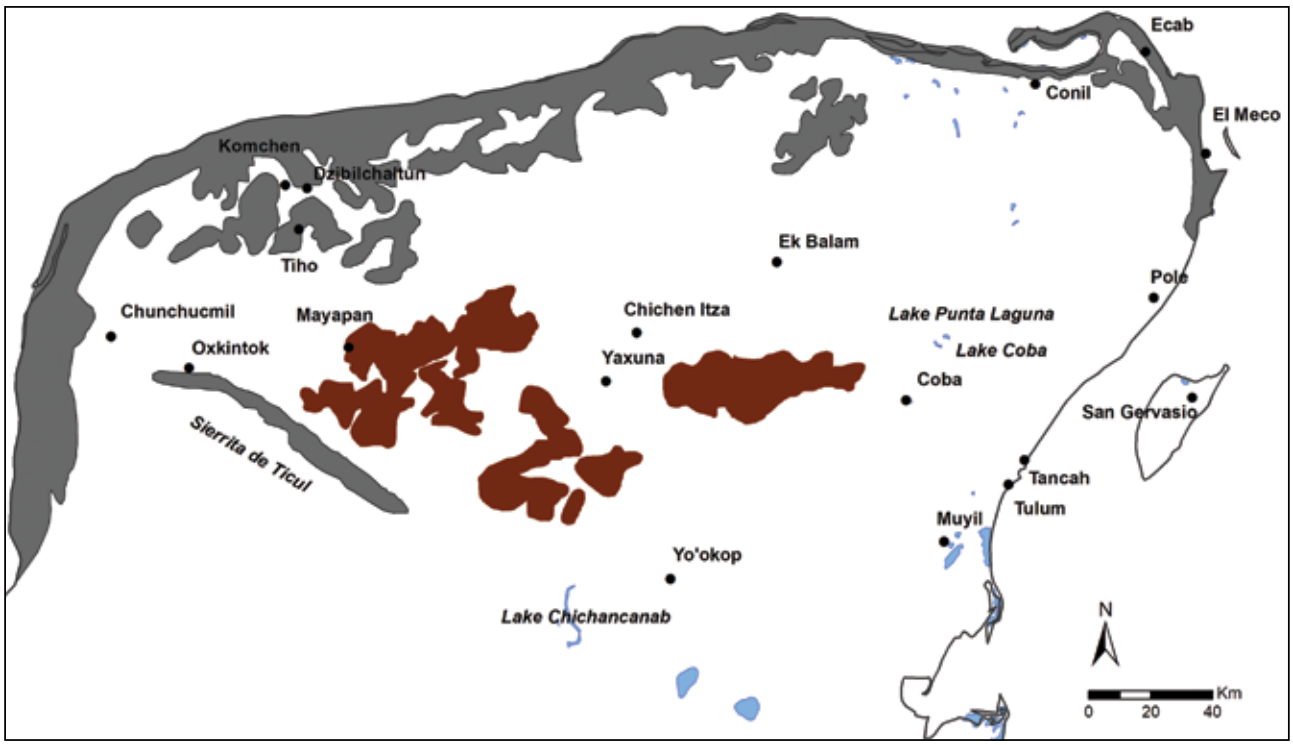


Figure 7.4. The grey areas represent agriculturally unproductive soils, while the black areas are those with fertile soils and sufficient precipitation levels (redrawn from Dahlin 2002: Fig.2).

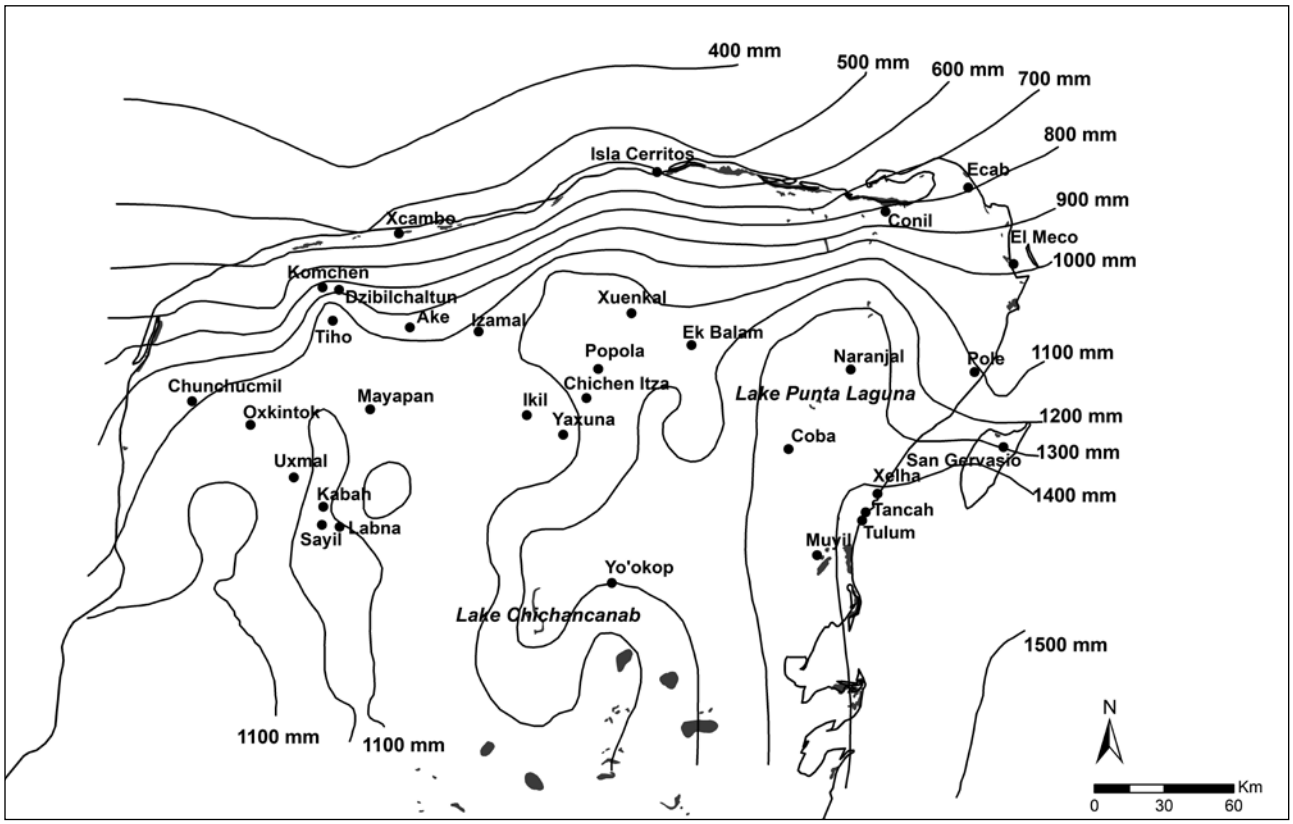


Figure 7.5. Distribution of annuall rainfall across northern Yucatan peninsula (rainfall gradient redrawn after Instituto Nacional de Estadistica Geografia e Informatica 1981).

henequen and even today, agriculture represents only a marginal activity (Andrews and Robles Castellanos 2004). Despite these inhospitable conditions, the results of the Proyecto Costa Maya (PCM), which conducted intensive archaeological surveys, showed that both the antiquity and density of occupation of this area was much higher than expected or indicated by previous explorations (Andrews and Robles Castellanos 2000, 2001, 2004). Dunning and colleagues (1998: 91) suggest that the communities living in this region most likely supported themselves with a combination of strategies, such as the use of depressions with better soils for intensive cultivation and orchards, the importation of organic soils from *savannas* and *petenes* for the construction of raised garden beds, the exploitation of forest and marine resources, and by importing food from the more productive areas, such as the Puuc region. In addition, at least some of the sites were favourably positioned to take advantage of coastal salt beds and trade (Dunning et al. 1998: 91; Andrews 1993; McKillop 2002, 2005; Golitko et al. 2012; Golitko and Feinman 2015; McKillop 2002, 2005). Successful adaptation to the conditions of the region might have been further aided by the fact that, despite the region's lack of surface water sources such as rivers, streams and lakes, the groundwater is very close to the surface and therefore easily accessible through the *cenote*s or wells (Fig 7.6). For example, at Dzibilchaltun, where the aquifer is only two to three metres below the surface (Matheny 1983: 168), Maldonaldo and colleagues (2012: 51) located 128 wells. In Chunchucmil, where the aquifer is even shallower, 14 well features were documented (Luzzader-Beach 2000: 398). Winemiller, in fact, notes that the northwest region of the Yucatan Peninsula has the highest well density in the area (2003: 328). According to Maldonaldo and colleagues (2012: 52), the large number and even distribution of these water sources across the landscape indicates that they were not controlled by elites.

It has been also argued that, paradoxically, in some respects the semi-arid climate of the northwest peninsula could have been beneficial for agriculture. Due to less heavy rains, the nutrients would have not been leached out of soils as quickly as in an area with higher rainfall, and the most labour-intensive process of clearing and burning of the *milpa* would be quicker and less dependent on right timing than in the wetter regions (Ringle 1985: 179). After fields were planted, the region's 'relative regularity of rainfall' would benefit the crops as well (Ringle 1985: 179). The research focused on assessing possibility of agricultural self-sufficiency and water resources in Chunchucmil indicates, however, that, at the very least during the periods with high population density, it is very unlikely that it would have been possible to produce enough food to feed the large population. Chunchucmil, during its apogee in the Early Classic, was one of the most densely inhabited cities in the Maya Lowlands with the estimated density of the central urban zone being between 42,400 and 47,600 inhabitants

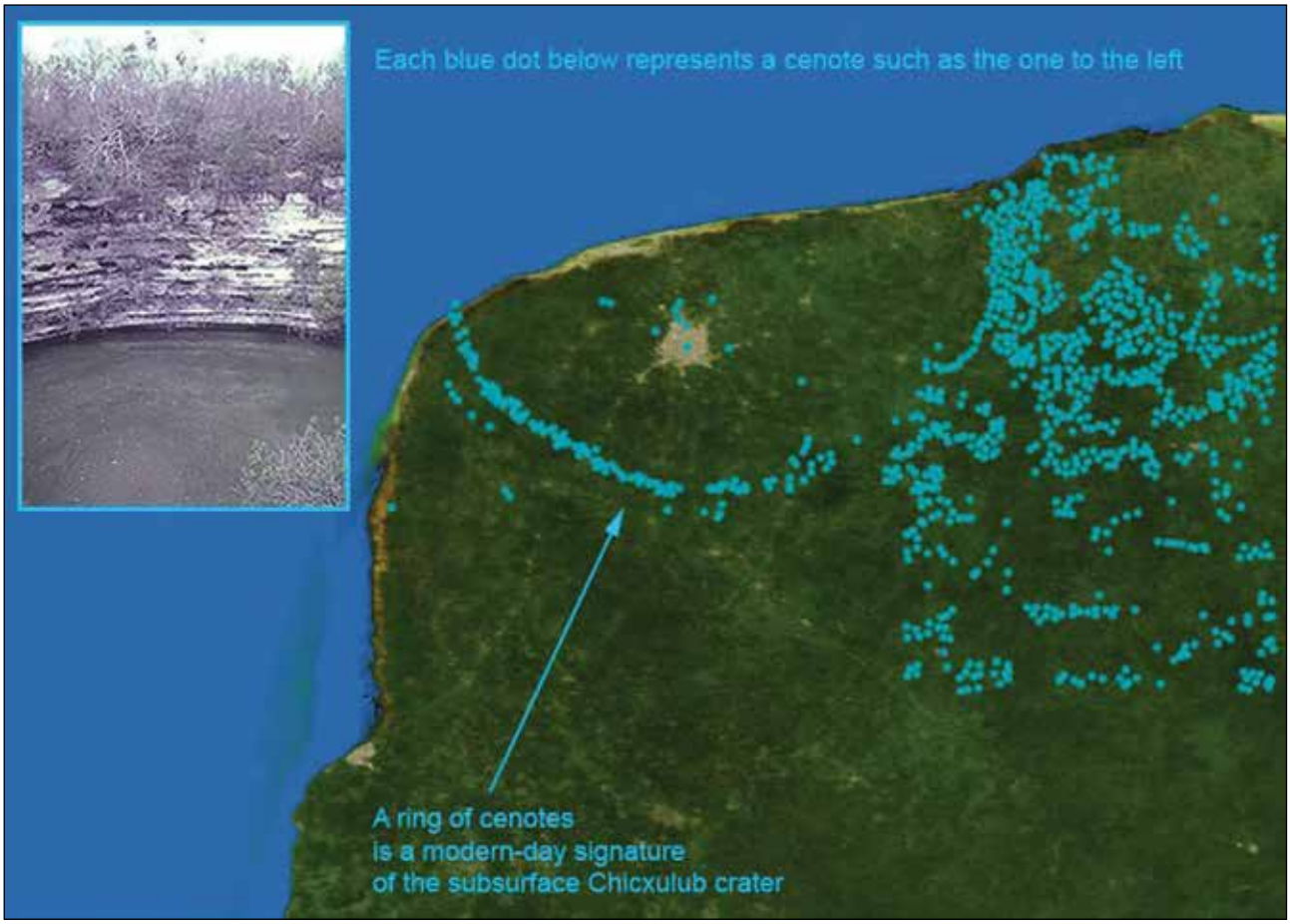


Figure 7.6. Northwestern region of Yucatan peninsula with cenotes (Lunar and Planetary Institute, Houston, TX, USA).

(Dahlin et al. 2005, 2007; Hutson et al. 2008; Magnoni 2008; Magnoni et al. 2012). It has been argued that even taking into account all forms of intensive cultivation strategies mentioned above, such as orchards, raised beds with imported organic soils and pot irrigation, while at the same time considering only the more conservative end of population estimates, the population numbers still do not fit the poor carrying capacity of the region (Beach 1998b). Furthermore, Luzzadder-Beach, studying the water sources, suggested that their quality and conditions would not have been favourable for intensively grown, hand-watered agriculture and orchard crops. This, according to Beach, is less of an issue with maize, which is 'potentially less limited by groundwater quality, but modern farmers, even using pesticides, still produce no more than enough maize on the thin soils of Chunchucmil to support their families, and certainly not enough for commercial sale' (Beach 1998b; Luzzadder-Beach 2000: 507). This is further supported by the analysis of human remains, which indicates that Chunchucmil's inhabitants were less reliant on maize in comparison to people from other sites, such as Yaxuna in the central part of the Yucatan Peninsula, or those living in the Peten region (Mansell et al. 2006). This implies that they complemented their diet with other resources, either from the region or traded from other areas. Therefore, according to these studies, the importance of trade and the import of food in this region should not be underestimated (Beach 1998b; Dahlin et al. 2005; Luzzadder-Beach 2000). Chunchucmil is seen as a trade centre, based on the suggested presence of a large marketplace and access to imported goods (Dahlin et al. 2007). One of the commodities that was commonly traded by the coastal communities was preserved fish (sun-dried and salted). Andrews (1983: 10) argues that: 'Fishing was a major industry of the Pre-Hispanic Maya, and coastal dwellers traded fish to neighboring sites in the interior in exchange for agricultural goods. To preserve the fish, they either roasted, sun-dried, or salted it … Salting was observed in the sixteenth century on the North coast of Yucatan and on the Pacific coast of Guatemala.'

7.3.2. Central Yucatan (northeast karst plain)

The northeast karst plain differs only slightly from the northwest in that there are some areas with deeper soils, especially in depressions, where the depth can range from 50 cm to 2 m in the southern part of the region (Dunning et al. 1998: 91). The use of depressions for intensive agriculture, such as *rejolladas* and *dzadzob* (Fig. 7.7), that also function as water sources, is documented in this region, for example in Ek Balam (Houck 2004, 2006). Ek Balam is placed advantageously in an area with approximately 1,000 *rejolladas,* some with prehispanic wells dug into their floors (Ringle et al. 2004: 506; Hanson 2008: 24).

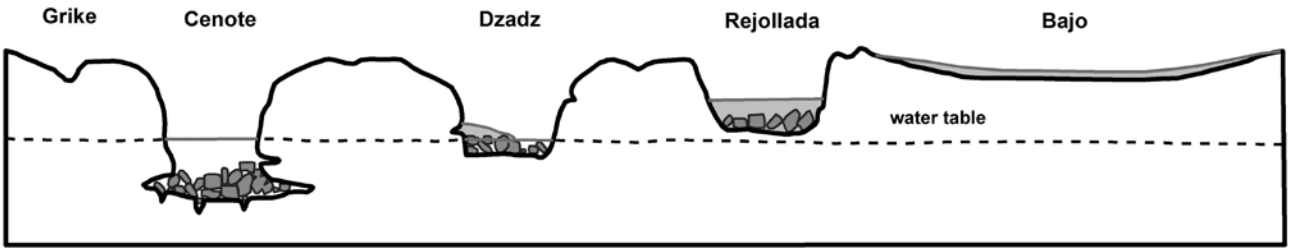


Figure 7.7. Different types of karstic depressions: *cenotes*, *dzadzob*, *rejolladas* and *bajos*, used either as water sources or for agricultural purposes. The main difference between these features is in terms of their position in relation to the water table (redrawn and modified from Munro-Stasiuk et al. 2014, Fig. 2).

Rejolladas, which can range between 25–100 m in diameter and between 5–15 m in depth, trap soil and moisture at the bottom and can be used for cultivation of plants and trees (Kepecs and Boucher 1996 in Houck 2006: 64). They are widely used by modern farmers to grow vegetables and fruit (Houck 2006: 64). *Dzadzob* are similar doline features, connected to aquifers, but are more variable in size; they can be used as natural wells and, like *rejolladas*, are used for water-sensitive plants, vegetables, fruits and even valuable crops such as cacao (Houck 2006: 65). These features create ideal humid microhabitats, which is 'especially important for tropical species, such as cacao, that do not typically thrive in the dry, karstic environment of the northern lowlands' (Glover 2006: 226). Dunning (1991) argues that Chichen Itza's strategic location within this region allowed it to take advantage of both the better agricultural lands and the north coast. *Rejolladas* are quite common in Chichen Itza and are often found associated with architectural features, such as *sacbeob* and *albarradas* (causeway systems and dry masonry walls used as field boundary markers respectively; Glover 2006: 227). Possible elite ownership of features such as *cenotes* and *rejolladas* was suggested, based on ethnohistorical documents and seems to be supported by archaeological data as well (it is possible, however, that these features only become elite-owned through time, and likely only during the Terminal Classic and Postclassic period). For example, in the Chikinchel region, *rejolladas* are often surrounded by *albarradas* or connected by them to structures. Moreover, at Chichen Itza ceramics that were found in structures associated with *rejolladas* are often of a ritual nature 'generally linked with elite activities dating to the Terminal Classic and Postclassic periods' (Kepecs and Boucher 1996:78; Lincoln 1991 cited in Glover 2006: 227). Similar walls around house plots, possibly dating to the Late Postclassic period, have been identified at Cozumel, Mayapan, Xelha, Tancah, Coba and in the Rio Bec region (Freidel and Sabloff 1984: 87). The walls at Cozumel and Xelha, dividing the area into rectilinear plots, are oriented roughly in cardinal directions, which, according to Freidel and Sabloff, might indicate that the use of houseplots was controlled centrally, possibly regulating the use of limited land and preventing its over-exploitation (1984: 88).

The relationship between water sources and settlement pattern in this region was examined at Ek Balam (Houck 2004, 2006). The researchers discovered that different types of sites (divided based on size and monumentality to Levels I–IV) are associated with different types of water sources (Houck 2006: 72–75). The largest sites (Level I–a capital Ek Balam and Level II–peripheral elite centres) seem to be located relatively close to water-only sources, such as *cenotes* and wells, however, none of these water sources is located near their centres. In comparison, Level III sites (lower elite centres) are positioned near multi-use *dzadz* features, which functioned as water sources, but were most likely also used for agriculture. Level IV sites (non-elite settlements and farming villages), were not only located next to water-only sources, but in the majority cases, the water source is located in the centre of the village (Houck 2006: 73–75).

The strong association of Level IV sites with water sources indicates the utmost importance of water for these communities. In contrast, water did not seem to play the primary role in determining the location of Level I and II sites. Houck suggests that the spatial distribution of these sites, especially the Level II sites' relative position to the capital Ek Balam (placed in cardinal directions), indicates that it might have been more politically than ecologically driven. On the other hand, the placement of Level III sites next to multi-use *dzazob* suggests that these features might have been exploited by the Ek Balam community as economic resources, such as growing cacao and other valuable crops (Houck 2006: 73–75).

Additionally, research by Castillo Borges and Vargas de la Peña (2009:142) indicates many hydraulic features in Ek Balam's centre and in the acropolis. Two artificial depressions of rectangular shape were documented in the northern plaza of Ek Balam and a large, modified *rejollada* was found at the back of the acropolis (2009: 142–143). In addition, many surfaces and architectural features of the six levels of the acropolis (Structure 1) were designed to drain and collect rain water. The water features in the acropolis structure include *chultunes*, and rectangular, circular and C-shaped reservoirs (Castillo Borges and Vargas de la Peña 2009: 143–144). One of the rooms of the acropolis (Room 63) in fact includes a wall painting that depicts a house with rain gutters, one of the hydraulic features existing in the acropolis of Ek Balam and possibly the only depiction of a hydraulic feature in Maya art (Seefeld 2017: 256). The considerable work and construction material invested in the construction of

the hydraulic system in the acropolis are, according to Castillo Borges and Vargas de la Peña (2009: 146), a clear indication of the importance of a consistent water supply for the inhabitants of the acropolis.

The importance of water for these communities might also be indicated by the small shrines built on or near the *dzadzob*, used for ritual purposes (Houck 2006: 75). Interesting, in this respect, is the fact that the rain god Chaahk is very prominent in northern lowland iconography and it is the only ancient Maya deity, recognised by its Classic Maya name, to be venerated by the modern Maya of Yucatan (Stuart and Stuart 1977). Furthermore, the causeway systems or *sacbeob* in several northern lowland sites, such as Yo'okop, Ichmul, Coba, Edzna and Chichen Itza are often connected to, and associated with, water management features, such as canals and reservoirs, or permanent water features (Scarborough 1993; Primrose 2003: 56). Such a connection might, according to some, indicate the control of water collection and redistribution (e.g., Primrose 2003: 56), although water as a resource does not seem to have been controlled in the northern lowlands. Some *sacbeob*, such as those in Ichmul and Yo'okop, were constructed during the Terminal Classic period and it is suggested that, in addition to population integration and movement of goods and people, they might have also been used for water petitioning rituals (Normark 2006).

7.3.3. The northeast Yucatan

The Coba-Okop region, located to the east of the northern karst plain, runs along the eastern coast of the Yucatan Peninsula. The area consists of a series of linear depressions, including small lakes with standing water. The majority of these linear depressions are in the Holbox fracture zone in the northern part of the region, which was defined by Fedick and Taube (1995) as the Yalahau region. Linear depressions in the Coba-Okop region have deep fertile soils, which were used for maize agriculture and possibly orchard cropping and are associated with settlements, especially around the lakes (Dunning et al. 1998: 92). In addition to the deep, productive soils, this region, especially the northeast corner, benefits from a higher amount of precipitation as a result of a rainfall anomaly (see Fig. 7.5). The Yalahau region receives between 1200 mm /yr and 2500 mm /yr (Allen and Rincon 2003: 16, figure 2:1), more than double the rainfall recorded in the drier parts of the Yucatan, which can be as little as 500 mm/yr in the northwest, but usually around 1000 mm/yr in the central part of the peninsula (Giddings and Soto 2003: 79–81). The anomaly is caused by the convergence of prevailing winds from the Gulf of Mexico and the Caribbean Sea over the northeastern corner of the peninsula, creating a region with more intense thunderstorms (Williams 1976: 17).

In the Yalahau region, the depressions contain a series of freshwater wetlands, which are seasonally inundated areas containing shallow clay soils over bedrock (Fig. 7.8). Due to their shallowness and low organic content, they do not allow for the construction of raised fields, instead they were managed using dikes and check dams (Morrison 2006: 44; Andersen 2001). They are a source of fresh water and, according to recent research, if managed well, they could have been used to grow fruit trees and exploit fauna such as fish, turtles and fresh water molluscs (Morrison 2006: 46). In addition, it has been suggested that the periphyton (a complex living material consisting of microalgae, cyanobacteria and different microbes, in which invertebrates such as snails and other freshwater molluscs live), which is abundant in submerged environments like the wetlands during the rainy season, may have acted as a natural fertilizer. Periphyton has higher nitrogen and phosphorus levels than modern fertilizers (Anaya et al. 1997, Palacios-Mayorga et al. 2003 cited in Morrison 2006: 46) and so wetlands soils containing periphyton may have been used to enrich poorer soils in other areas, increasing their yields (Morrison 2006: 46). Numerous rock alignments were located in the wetlands (78 rock alignments, with the longest being 70 m long in El Eden's wetlands, Fedick and Morrison 2004: 211). While they were clearly used to modify the wetlands, the precise function of this system of rock alignments is still unclear. It has been suggested that the system was used to modify wetland ecosystems to increase agricultural productivity, with a function probably closely related to sea-level fluctuations. The dating of these features is difficult, however, the archaeological sites in the vicinity date almost exclusively to the Late Preclassic or Early Classic periods (Fedick and Morrison 2004: 211–213). The abandonment of the Yalahau region during the Late Classic period may have been due to changing sea levels that might have disrupted wetland agriculture (Fedick and Morrison 2004: 213).

Unlike many other regions in the northern lowlands, water is not scarce in Yalahau. In addition to the wetlands and cenotes, it was also relatively easy to dig wells because the groundwater level is very close to the surface (Glover 2006: 679). The lack of *chultuns* in the region is, according to Glover (2006: 679), a good indication that people were feeling relatively secure in their ability to acquire water, however, it has also been noted that most settlements are still located close to water, especially near *cenotes* (Bell 1998: 76 cited in Glover 2006: 279).

The importance of water features, such as *cenotes* or caves, was not solely based on their function as water sources, although in the dry northern lowlands without rivers and streams they certainly were important. Caves and *cenotes* served as ritual portals to the underworld and as places for ancestors and deities, such as Chaahks (Redfield and Villa Rojas 1967; Rissolo 2003). Research in the Cochuah region, located in the Quintana Roo depression, focused on cave use (and other natural water sources) and provided evidence of 'sustained cultural exploitation, principally during the Terminal Classic period' (Johnstone 2012: 385). In addition, the areas around caves experienced their highest occupation levels during this period (Shaw 2008). In Belize, according to Moyes and colleagues (2009;

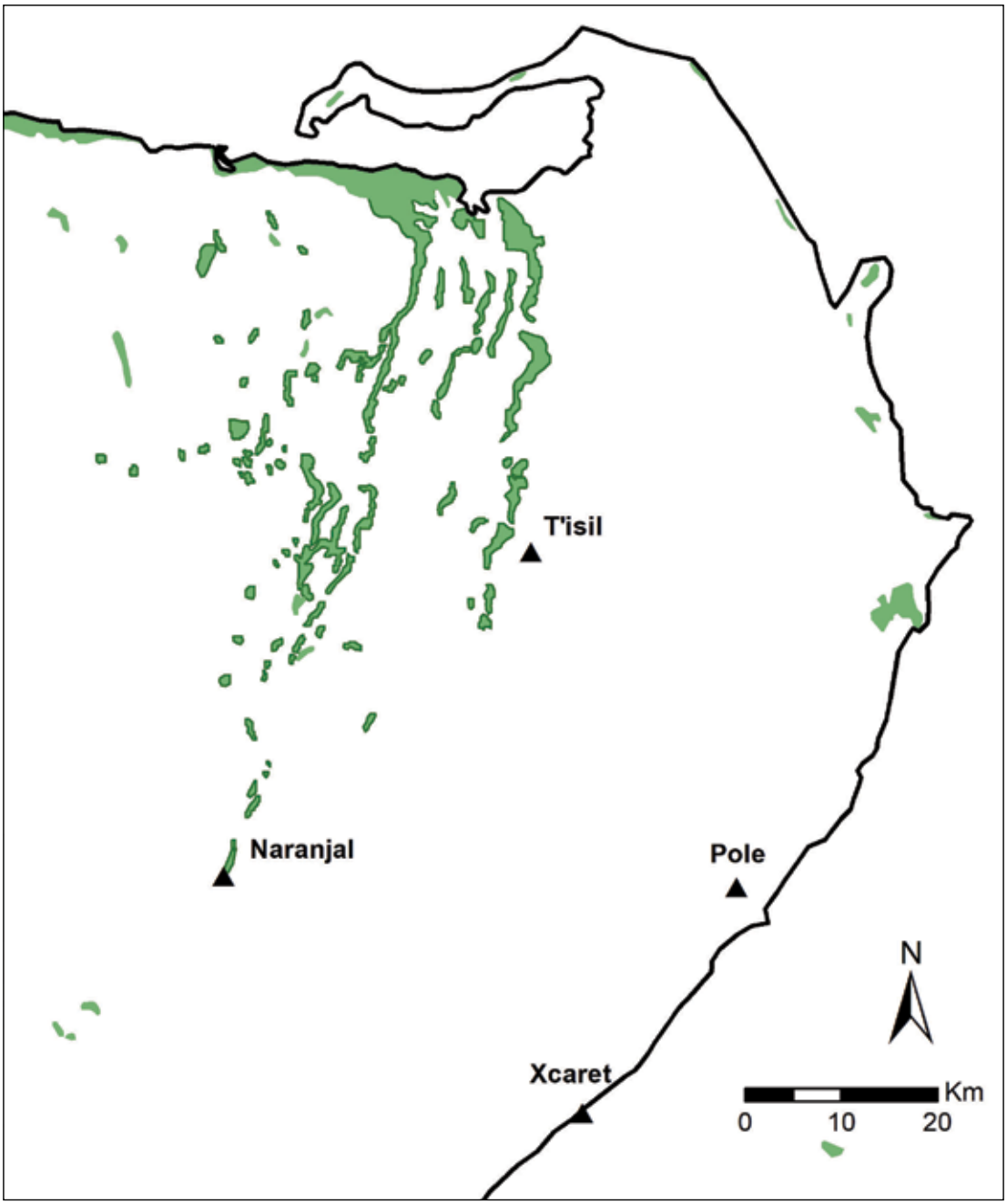


Figure 7.8. Map of Yalahau region, with green areas representing wetlands (redrawn and modified from Fedick and Mathews 2005, Fig.2.2).

Moyes 2006), the Terminal Classic also shows an increased use of caves, which is associated with a Maya drought cult and ritual response to environmental stress. Even today in the Cochuah region, shamans (*h-men*) use caves to collect *zuhuy ha* (virgin water) for their rituals, especially those rituals connected to the *cha chaac* rainmaking ceremonies, and Johnstone (2012: 384) mentions that 'it is tempting to think that these kinds of behaviours had ancient antecedents'. In Chapter 8, colleagues and I argue that indeed there is a continuity in these behaviours since at least the Classic period, and we discuss two specific rituals appearing in the Terminal Classic texts as possible predecessors of rain-calling ceremonies, potentially linked to episodes of environmental stress.

In addition, research focused on the relationship between water sources and settlement in the Cochuah region indicates that there was a change in use of water sources between the pre-colonial and Colonial periods. Based on settlement data, there is no significant difference in the settlement distribution in the Precolumbian times (Normark 2008: 213). However, in the Colonial period, settlement patterns show a strong reliance on permanent water sources, which, according to Normark (2008: 224, 230), might be due to the fact that Colonial and Spanish settlement was much more congregated and much less flexible in terms of mobility in case of drought. For example, the Colonial and Spanish settlement did not extend beyond the Chicxulub fracture zone, which

contains karst water features. In contrast, there were several Prehispanic sites found south of this zone, in an area without natural water sources, which, again according to Normark (2008: 225), is because of the deeper soils, resulting in better agricultural potential. To survive in this area people would have dug wells (Winemiller 2003).

Contrary to the expectations of palaeoclimatic models, survey research shows the increased presence of prehispanic sites around caves, especially the 'dry' caves (without access to permanent water sources), during the periods of droughts (Normark 2006, 2008: 224). Normark (2008: 224) argues that this has less to do with caves as sources of water (which would have been insufficient) and more with their ritual importance and with 'spreading risks to several econiches'. As mentioned above, for the ancient Maya, caves were important ritual places, but they were also important because they were the only places containing water throughout the year (Brady and Prufer 2005; Rissolo 2005; Normark 2008: 231). Furthermore, as Normark argues, the land around caves, especially in the southern part of the region without permanent water sources, would not normally have been used as much. Perhaps left untouched for some time and therefore much less affected by deforestation, these places would become more attractive during the dry periods as sources of more fertile soils (Normark 2008: 231–232).

In comparison, during the Colonial period, these areas around 'dry' caves seem to be left unoccupied; there were no colonial settlements found around caves in the Cochuah region, and there is less evidence of the use of caves for ritual purposes. This, apart from the reliance of colonial settlements on permanent water sources, can be explained by the Spaniards' attempts at preventing the Maya from using the caves for what was perceived by the Catholic Church as pagan rituals (Normark 2008: 231).

7.4. Why did agricultural and water management strategies change?

In Chapter 3 I discussed several different hypotheses regarding the drivers behind changes to more intensive agricultural and water management strategies, how these strategies changed through time and how such changes might reflect on settlement patterns and socio-political issues. The main proposed factors were population pressure, land degradation (due to slash-and-burn agriculture), climatic drying trends (both in the Late Preclassic and Terminal Classic period) and socio-political decisions. Before re-evaluating this evidence, I would stress that, in many cases, the dating of agricultural and water management features is very complicated or virtually impossible, and in other cases these features have only been dated indirectly. These factors need to be taken into account when attempting to make chronological comparisons between the appearance and changes in agricultural and water management features and changes in archaeological or climatic records, which often contain many uncertainties of their own.

Bearing these caveats in mind, what changes can we see and how do they relate to the proposed drivers of population pressure, land degradation, climatic drying trends and socio-political decisions?

7.4.1. Population pressure

If we examine the chronology of the intensification of agriculture, specifically in the rare cases where we do have dates for the development of features, such as agricultural terraces, rock-alignment features or wetland agriculture, the intensification usually pre-dates the periods with significant increases in population (normally the Late Classic period). These intensive farming techniques seem to have been introduced very early in Maya history and most of them date to the Late Preclassic/Early Classic period (Beach et al. 2002; Wyatt 2005, 2008), although Wyatt (2009: 7), argues that the terracing in Chan area might have been constructed as early as the Middle to Late Preclassic period (650 BC–AD 150). This seems to disqualify population pressure as a motivator behind these innovations.

However, it might be too simplistic to expect that these intensive farming techniques would be developed only once the population maximums have been reached. Depending on the agricultural potential of the area, in some cases the high population densities might not have been reached without the adoption of the intensive agriculture in the first place. For example, although it has been noted that the development of Chan terraces might be related to the need for more food production for nearby sites such as Xunantunich, the conclusion that 'terraces were being constructed prior to the Late Classic population explosion, contrary to accepted theories of agricultural intensification' (Wyatt 2005: 21), is still maintained. If we look closer at the occupational changes, however, while both Chan and Xunantunich reached their population maximum during the Late Classic period (AD 600–780), there is clearly a significant increase in Xunantunich's population (44.3%) already during the Early Classic period (AD 300–600). In fact, there is a significant increase in population during the Early Classic within the whole lower Mopan Valley (Peuramaki-Brown 2012: 325).

I am not arguing that this increase of population was the catalyst for adoption of terracing in Chan; if the dates are correct and the terracing in Chan was developed already during the Middle/Late Preclassic period, even the Early Classic increase of population would be too late to serve as an impulse. I am only using this example to illustrate that sometimes we might forget to take into account the necessary lag between the events**.**

Moreover, I am not sure if we yet sufficiently understand Preclassic demographic change and the relationship between the Preclassic population densities and agricultural carrying capacity. Recent research shows that at least some of the discussed areas, such as northwest Yucatan or the Yalahau region, already had high population densities

during the Preclassic period, earlier than has been generally assumed, only to later experience demographic collapse (see settlement occupation tables in Chapter 6). Fedick and colleagues (2000) suggested that the modification of the Yalahau wetlands may have occurred during the Late Preclassic/Early Classic transition, which represents a peak in population levels in this region.

With the recently increased focus on the Preclassic period, it is becoming clear that this period of Maya history has been underestimated for a long time. Ongoing research indicates that the Preclassic period (especially the Late Preclassic) saw, in addition to monumental construction, the development of the concept of Maya kingship**,** the evolution of hieroglyphic writing (Saturno et al. 2005, 2006; Kováč et al. 2016) and innovations, such as intensive agricultural strategies and water management systems.

While the adoption of intensive farming techniques due to population pressure in the above-mentioned cases remains questionable, their relatively extensive use and expansion in later periods, especially during the Late and Terminal Classic is more obvious. Examples such as extensive terracing in the Xunantunich and Chan areas, the ditched field system in Baking Pot, water management systems in Nakum and Baking Pot and decreased land availability in Peten Lakes region, all during the periods of population explosion in these regions, might support the association of intensive farming techniques and population increase.

Unfortunately, it is even more difficult to judge the timing of the adoption of intensification strategies and their changes in northern Maya lowlands, as the dating of the use of features such as *rejolladas*, *dzadzes* or wetlands is mostly unfeasible. In rare cases, at least indirect dating might be possible. Archaeological sites in the vicinity of rock alignments in the Yalahau wetlands date almost exclusively to the Late Preclassic or Early Classic periods (Fedick and Morrison 2004: 211–213), indicating that it is very likely that the intensification of agriculture in the northern lowlands took place early, approximately at the same time as in the southern lowlands, during the Late Preclassic/Early Classic period.

7.4.2. Land degradation

Another possible factor is land degradation, or more specifically soil erosion, at least partially as a consequence of slash-and burn-agriculture. The data from the Belize Valley and surrounding areas, such as the Vaca Plateau and Northern Belize, show that terracing was used extensively in these regions (although it seems to be relatively rare in other areas of Maya Lowlands[20], Dunning and Beach 1994: 52). As noted above, some of the terraces were developed during the Preclassic period and expanded with time and growing populations. Such early construction dates indicate that there might be other factors behind their origin than population pressure. Data from Peten lakes show substantial increase in soil loss and sedimentation rates in the Preclassic period, represented by thick deposits of 'Maya clay', which differ from more 'organic-rich gyttja' deposited both before and after Maya occupation (Anselmetti et al. 2007: 915; Binford et al. 1987; Deevey et al. 1979; Rice 1993). Lake Salpeten records show the greatest soil loss during the Middle and Late Preclassic periods (700 BC to AD 250), which, although still high in comparison to pre-Maya rates, declined during the Late Classic period (AD 550–830) (Anselmetti et al. 2007: 915). Similar sedimentation rates were found in cores from other Peten Lakes, such as Peten Itza (and elsewhere in the Maya area), all indicating that the high soil erosion rates predate population maxima (Anselmetti et al. 2007: 917; Hillesheim et al. 2005). As Anselmetti and colleagues (2007: 915) note: 'The most rapid soil loss occurred early during initial land clearance, suggesting that even low numbers of people can have profound impacts on lowland tropical karst landscapes'. Such a correspondence in timing (although only in very broad terms) between high soil erosion rates and the development of slope conservation techniques might, therefore, not be coincidental and this has been argued to be causal by several researchers since the 1980s (e.g., Turner 1983; Beach and Dunning 1995, 1997; Beach et al. 2002, 2006). Land degradation as a factor is further supported by the fact that in many regions with extensive terracing and slope conservation techniques, dating predominantly to the Classic period (e.g., Northern Belize, Petexbatun in Guatemala and Rio Bec region in Mexico), the presence of these features co-occurs with lower rates of sedimentation, while their absence co-occurs with greater evidence of erosion (Beach 1998a; Beach et al. 2002, 2003; Wingard 1996).

7.4.3. Drying trends

The adoption of intensive farming techniques due to drying trends has also been proposed. Looking at the evidence from the palaeoclimatic proxies derived from lake sediments and stalagmites, periods of low precipitation or droughts were identified around AD 200. The record from the Cariaco basin shows a period of drought at AD 200 (Haug et al. 2003), records from Lake Chichancanab indicate decreased precipitation during the period from AD 125–210/AD 90–230 (Hodell et al. 2001, 2005a), a stalagmite from Macal Chasm cave shows dry period between AD 200–350 (Webster et al. 2007), or AD 250–330 (Akers et al. 2016), and the Yok Balum stalagmite indicates a dry period between AD 200–300 (Kennett et al. 2012).

As discussed above, the earliest appearance of terraces is placed in the Late Preclassic/Early Classic period (~AD 250, Beach et al. 2002), although some perhaps earlier (e.g., Wyatt 2005, 2008, 2009). In addition, some of the *bajo* sites in Peten Lakes were occupied from the Late Preclassic period and archaeological sites in the vicinity

[20] It is possible that in some cases the evidence has not been uncovered yet. It is becoming easier due to new technology such as LiDAR (for example, the recently-discovered terracing at Barton Creek in Belize (Awe et al. 2015) or around Uaxactun and other sites in Northern Guatemala (Hightower et al. 2014, Chase and Weishampel 2016, Canuto et al. 2018, Kováč 2019).

of the rock alignments in the Yalahau wetlands date almost exclusively to the Late Preclassic or Early Classic periods (Fedick and Morrison 2004: 211–213). Likewise, some small-scale water management projects have also been dated to the Late Preclassic period (Scarborough and Burnside 2010), and it is argued that these were developed in response to unpredictable precipitation and to allow people to take better advantage of the local environment (Kenneth and Beach 2014). Given such timing, it is tempting, albeit tentative, to suggest that the drying trend in the Late Preclassic period was further exacerbated by problems with deforestation and soil erosion and contributed to the development of intensive farming strategies, such as wetland agriculture and slope conservation techniques.

The drying trend during the Terminal Classic period has, in turn, been correlated with the wider use of intensive agricultural techniques, especially wetland agriculture and terracing, but also with changes in water management and associated changes in settlement patterns. Relatively high rainfall during the latter part of the Early and Late Classic periods (~AD 400–700) was followed by drier conditions interspersed with periods of droughts during the Terminal Classic (with peaks, and slight variations depending on region and proxy, placed around AD 760, 810, 860 and 910; Haug et al. 2003; Hodell et al. 2005a; Stahle et al. 2011). In the study regions, during the Late/Terminal Classic period, we see extensive use of terracing and ditched field systems as well as complex water management systems, however, these had already been used for centuries and with a growing population, expansion of these features would have been inevitable. Furthermore, the broad and sometimes uncertain dating of these features and their use does not allow for precise identifications of periods of their increased use or expansion; therefore, correlation with the Terminal Classic drying period remains, in many cases, speculative. However, some of the potential evidence includes settlement dispersal in the Cochuah region during the Terminal Classic period, which has been argued to be an adjustment strategy to the limited water during this time (Shaw 2008). Perhaps as a part of this Terminal Classic dispersal, occupation in areas around caves in the Cochuah region increased in order to both exploit the fertile soils in previously underused areas in response to drier conditions as well as to perform rituals (Normark 2008: 224). The increased use of caves for ritual purposes related to drought was also reported in Belize caves (Moyes 2006; Moyes et al. 2009).

Furthermore, the Yalahau wetlands region, which had been occupied throughout the Preclassic and Early Classic periods, is almost completely abandoned during the Late Classic/Terminal Classic period but reoccupied later in the Late Postclassic (Glover 2006: 742, 756; Taube and Gallareta Negrón 1989). Taking into account the situation in the wider region around Yalahau, the Classic and Early Postclassic abandonment, especially after the period of heavy occupation, represents an anomaly (Fedick and Morrison 2004). The areas to the west and south, such as the Chikinchel region and the site of Coba, grew during the Classic period and experienced continuity of occupation throughout the Postclassic (Fedick and Morrison 2004; Kepecs 1998). Fedick and Morrison (2004: 215) therefore argue that the abandonment of Yalahau may be linked to 'the changing suitability of the wetlands for cultivation in response to changes in climate and hydrology' (although in this case, the abandonment of the wetlands is associated with fluctuating Holocene sea levels, rather than specifically with droughts during the Terminal Classic period: Froede 2002; Morton et al. 2000 cited in Fedick and Morrison 2004: 213; more direct association between abandonment of wetland environment and drought was argued in the case of the Blue Creek wetlands in northern Belize (**Fig. 7.9**), which show disuse after the Terminal Classic period: Luzzader Beach et al. 2012). The region is reoccupied in the Late Postclassic. However, it is unclear how much wetland management took place during this time period, as it seems that the large majority of the sites in the vicinity of rock alignments associated with wetland manipulation date to the Late Preclassic or Early Classic periods. If the Late Classic abandonment of the Yalahau region was due to changing groundwater levels, possibly disrupting wetland agriculture, the question then is: with the returning higher precipitation during the Postclassic period, was the agricultural management of the wetlands renewed as well? Within the above discussed case study regions at least, I have not come across any evidence for intensive types of agriculture in the Postclassic period, and Guenter (2014) argues that intensive agriculture is one of the features of Classic Maya society that disappears after the Terminal Classic period. Dunning and Beach (2010: 385) suggest that it was predominantly slash-and-burn agriculture that was used during the Postclassic, reflecting the lower population densities. However, considering the many different types of intensive agricultural techniques used, especially in the northern Maya lowlands (e.g., *rejolladas, dzadzob*), which are essentially un-datable, the disappearance of intensive agriculture after the Late Classic period might be a difficult point to prove.

7.4.4. Socio-political complexity

Socio-political hypotheses emphasise that those decisions often perceived as resulting from ecological factors are, in fact, missing the point and that 'the ecological situation for a society always is the result of earlier socio-political decisions that have transformed environment' (Normark 2008: 230). The main argument here stands on the premise that a growing elite class and non-agricultural specialists required more labour and sustenance, which could only be gained by attracting more subjects who would be providing the sustenance, using intensive agricultural strategies and water management capable of supporting the high population densities. We might assume that such a scenario would involve some centralised control over subsistence strategies and resources. Within the case study regions we do see that construction of extensive terracing systems, or ditch field systems at least in some areas such as in Caracol or Baking Pot, might have been controlled from the top down during the Late/Terminal Classic period,

Figure 7.9. Wetland fields near Blue Creek, Belize (from Luzzader-Beach et al. 2012, Figure 1).

given their spatial organisation and alignments (Chase and Chase 1996: 808; Bevan et al. 2013; but see Wyatt 2008: 11). Similarly, centralised control of use of houseplots at Cozumel and Xelha (and possibly several other sites in northern lowlands) during the Late Postclassic has also been suggested, based on the walls surrounding them and dividing them into rectilinear plots, oriented roughly in cardinal directions (Freidel and Sabloff 1984: 84–90). Furthermore, some intensive agriculture features, such as *rejolladas* in the northern lowlands, might have been owned or at least controlled by elites during the Terminal and Postclassic period, based on ceramics found in the structures associated with them (Kepecs and Boucher 1996: 78; Lincoln 1991).

There is also evidence of water management features, such as complex water drainage systems constructed in the monumental complexes at Nakum during the Early and Late Classic periods and at Baking Pot during the Late/Terminal Classic. At least at Nakum, it is argued that these systems might have had both a utilitarian as well as a ritual function (Zrałka and Koszkul 2015). Taking a closer look at the dating of features presumed to be constructed under some kind of centralised authority, they are all too late to be considered as a motive for the development of agricultural intensification or water management strategies. In fact, according to Wyatt (2008: 11), construction and maintenance of the earliest known terraces in Chan community were controlled by local households. On the other hand, socio-political decisions involving centralised control of subsistence strategies and water resources may have played an important role during the Late/Terminal Classic period and in the northern lowlands, even during the Postclassic period. Projects such as the ditched field system at the Bedran group at Baking Pot and the extensive terracing systems in the Xunantunich hinterland might have been capital investments, developed in order to encourage the production of agricultural surpluses by local communities for nearby centres. Control over water, especially in areas without natural water sources, may have given kings certain authority over their subordinates and helped to centralise and consolidate their political power (e.g., Lucero 1999, 2002, 2003, 2006a, b; Scarborough 1998).

7.4.5. Implications of agricultural and water management changes

We need to examine more closely how changes in agricultural and water management strategies reflect back on settlement patterns and socio-political issues. One perhaps obvious, but still important, fact to mention is that in the majority of the discussed regions, Maya settlements are distributed either along rivers with fertile alluvial soils or, where there are no rivers such as in northern lowlands, intensive settlement is highly correlated with wetlands or water features such as *cenotes*, *rejolladas* or *dzadzes* that were used both as sources of water and for intensive agriculture. One of the exceptions in this respect is the northwest corner of Yucatan, where dense

settlement existed in the area with low rainfall and thin, unfertile soils. The inhabitants of the area must have relied on different resources other than the marginal agriculture. However, looking at the variability of water management and water features used, these are clearly linked to different environmental conditions and this is especially pronounced in the northern lowlands. As noted by Winemiller who studied water management in Yucatan, 'using their technology including an ability to construct water storage features, the ancient Maya were able to populate areas having no apparent sources of water management' (2003: 257). The close association of the settlements with water sources in the northern lowlands might also be a reason why, as argued by Winemiller, water was not a commodity controlled by the elite in this area, (2003: 257; although the Puuc district, where water reservoirs are present might be an exception, e.g., Isendahl 2001). This is illustrated by cases such as Ek Balam, where the location of elite residences seems to be less conditioned by the proximity to water sources than that of non-elite residents. The fact that all the lower level sites are located close to water sources might indicate a different perception of the importance of water in the northern lowlands (given the lack of rivers and streams) and, therefore, water was not something that elites would be able to use to control people.

On the other hand, the association of water management features with causeway systems and elite architecture at some northern lowland sites could indicate that the possibility of some level of control cannot be excluded altogether (e.g., Primrose 2003: 56). Moreover, *sacbeob*, besides being used for practical reasons, such as the integration and movement of people and goods, may have also been used for ritual purposes (Shaw 2008: 220). The picture of water control by the elite is slightly clearer in the southern lowlands, at least in areas without natural water sources. Due to a much deeper aquifer, the choices of possible water storage features would have been much more limited than in the northern lowlands (for example, the water table at the Vaca Plateau is 60 m below the surface (Alt 1995: 87). With the Classic period population movement to previously unoccupied areas to exploit fertile soils, the lack of natural water sources may have been exploited eventually by the elite in some southern lowland sites where they built and controlled large reservoirs (Tikal, Nakum, Caracol, Calakmul). Such a scenario, however, seems to often be overemphasised, especially in the theories which propose that control over water gave kings power over their subjects, which then was lost when, during the dry periods, they were not able to provide enough water (e.g., Lucero 1999, 2002, 2003, 2006a, b; Scarborough 1998). While such situations may have existed at some sites, in the majority of regions, especially in all of the study areas, large urban reservoirs were not the only water systems used. Furthermore, Johnston (2004: 287) argues that in many cases, any limits on access to the large reservoirs near ceremonial plazas would have had little effect on a rural population that was able to obtain water from non-centralised water sources (see also Davis-Salazar 2003; Weis-Krejci and Sabas 2002). For example, all of the sites in the Belize Valley/ Peten Lakes region are located on, or in the vicinity of, perennial rivers or lakes. In addition, during periods when water from rivers would be difficult to use (i.e., during floods), people would have been able to fall on other water sources, such as seasonal streams, wells or *aguadas*. There are several seasonal streams and *aguadas* at Baking Pot and Barton Ramie. Likewise, in Peten, Bullard observed that the maximum distance between *aguadas* and ancient Maya remains usually does not exceed two kilometres (1960). Bullard's observations were further supported by other archaeological surveys (Ricketson and Kidder 1930; Lundell 1933; Culbert et al. 1990; Lohse 2004).

Finally, it is often argued that the success brought by the intensification of agricultural strategies and water management to the Maya eventually also led to their destruction. The intensive agricultural techniques, such as terracing, and complex water management features, such as reservoirs, required constant attention and maintenance. Eventually they were abandoned, due to political changes, warfare, lack of trust in rulers, or due to environmental problems, such as deforestation, soil erosion or droughts. People seem to have returned to slash-and-burn agriculture (where possible), or possibly subsidising agriculture with more diverse economic and subsistence strategies, thus reducing the impact of agricultural failure. This would have led to changes in settlement patterns, and some of the observed changes mentioned in the previous chapter, such as the growth of coastal communities that indicates increased reliance on maritime resources and growing and changing trade networks and salt production (Andrews 1993; Golitko et al. 2012; Golitko and Feinman 2015; McKillop 2002, 2005).

7.5. Summary

Based on the evidence, one of the most important conclusions is that both diversification of agricultural strategies and the first development of water management in the discussed case study regions occur very early in the Maya history. Given our current understanding of demographic patterns, especially those during the Preclassic and Classic periods, the evidence does not support population pressure as a driver behind the initial intensification of agricultural and water management strategies. However, it is very likely that population played a larger role in the relatively extensive use and expansion of these strategies in the later periods, especially during the Late and Terminal Classis periods.

On the other hand, although riddled with dating uncertainties, corresponding chronologies between the highest soil erosion rates (700 BC to AD 250) and the development of intensive agricultural techniques/ conservation strategies (~AD 250, with some possibly as early as 650 BC–AD 150) might indicate that land degradation, at least partially as a consequence of slash-and burn-agriculture, is a more likely factor than the population pressure. Furthermore, diminished rainfall during the Late

Preclassic period (~AD 200–250), also corresponding chronologically with agricultural and water management changes, and possibly further exacerbating problems with deforestation and soil erosion, might have contributed to development of intensive farming strategies, such as wetland agriculture and water management techniques.

The situation is even more complicated during the Late/Terminal Classic period, which sees expansion and extensive use of intensive agricultural techniques and water management strategies. In this case, however, it is difficult to determine whether this occurred as a consequence of rising populations in general, the rising elite in Classic Maya society, or as a consequence of a drying trend during the Terminal Classic period; or a combination of these; it is also difficult to distinguish between cause and consequence. Perhaps the evidence of increased centralisation of subsistence and water management strategies, as indicated by possible capital investments such as extensive terracing, a system of ditched fields, elite-owned intensive agricultural features and aligned house plots, or large urban reservoirs, could suggest a prominent role for socio-political decisions during this period (and even the Postclassic period in the northern lowlands). However, were these socio-political decisions driven by population pressure, by attempts to consolidate the elite's political power or by environmental deterioration?

All of these tentative ideas and interpretations will next be discussed, looking at the political and cultural history, using epigraphic/iconographic evidence in Chapter 8) and finally I will attempt to synthesise all of the strands of evidence in Chapter 9.

8

Epigraphic Insights into Culture, Society and Climate Change

Co-Authored with Christophe Helmke and Andrew Bevan

8.1. Introduction

Many studies dealing with human environmental relationships have been criticised for being environmentally deterministic and ignoring the importance of cultural and social factors, such as religion, ideology, political strategies and economic organisation. As Tainter (2000: 337) points out, a better understanding of a society's responses to climactic stress comes from understanding the history of that society in a wider context. To complement and contextualise the previous chapters focused on settlement, environmental histories and landscape management, this chapter aims to briefly explore the cultural and political trajectories of Maya society in the two case study regions. Based mainly on the evidence drawn from the hieroglyphic records, the discussion is inevitably limited to the Classic and partly the Postclassic periods to which the large majority of the hieroglyphic texts date.

The chapter is organised into three different sections. The first part offers a brief review of the cultural and political history of the Eastern Central Lowlands encompassing both the Belize Valley and Peten Lakes regions and northern Yucatan regions, as suggested by hieroglyphic inscriptions; in some cases complemented by archaeological evidence. The second part discusses specific changes observable in hieroglyphic texts and iconography through time, focusing on the transition between the Classic and the Postclassic period (i.e., the Terminal Classic) in each region. The third part builds on observations discussed in the two preceding sections, and combines them with observations from the ethnographic studies (discussed in Chapter 3), which indicate that religious ceremonies and rituals play a significant role when coping with extreme climatic events. The hieroglyphic records are, therefore, explored for evidence of environmental stress and related ritual activities.

8.2. Cultural and political history

8.2.1. Eastern Central Lowlands

Despite the fact that the glyphic texts from Central Belize are relatively scarce, those that we do have make it clear that the rulers of these relatively small polities tried to portray themselves, at least in writing and imagery, as being on the same footing as Maya lords from other, often much bigger, polities. This observation is based on emblem glyphs and royal titles used by Maya lords from the sites of Baking Pot, Buenavista del Cayo, Pacbitun, and Xunantunich (Reents-Budet et al. 2005; Helmke 2012; Healy et al. 2004; Helmke et al. 2006; Martin and Grube 2000; Leventhal and Ashmore 2004; Helmke and Awe 2012). Emblem glyphs were until relatively recently viewed as toponyms, or references to specific places (Mathews 1991). According to the latest consensus, however, emblem glyphs were primarily high-ranking royal titles, usually referring to rulers of particular royal courts or noble houses (Grube 2000: 549–550; Martin and Grube 2000:17–19; Martin 2004; Helmke and Awe 2012). As Helmke and Awe (2012: 71) point out, given this newer understanding, emblem glyphs should in theory represent the same title regardless of who used it, therefore ancient Maya rulers claimed equality 'in rank and status', at least in writing. Over two decades of research have shown, however, that not all kings, and by extension not all royal courts, had the same power, authority, or status (Martin and Grube 1995, 2000: 17–21). In the texts we thus see that more powerful kings oversaw the installation of vassal kings, and perform joint rituals, marriages and gift exchanges to seal these hierarchical alliances (Martin and Grube 1995, 2000: 17–19).

That being said, if we look at the map of the eastern part of the central Maya lowlands and note the distribution of the major centres, it is clear that the fates and histories of Central Belizean sites were, by virtue of location alone, affected by the dominant sites of Naranjo to the north, Caracol to the south and Tikal to the west (Fig. 8.1). Being smaller and less powerful, and at the same time located on rich agricultural land along the Mopan, Macal and Belize rivers, these intermediary sites would be of interest to the above three powerful primary kingdoms, and in the middle of the changing alliances and power shifts (as discussed in Chapter 3).

It is, therefore, in this complex environment of hierarchical networks of alliances and vassalhoods that we need to look at the developments and changes taking place at the sites in Central Belize (at least between the Classic and Postclassic periods) for which we have some epigraphic records.

8.2.2. Relations between Naranjo, Caracol and other Central Belize sites

Based on the available epigraphic evidence, the political histories of the Belize Valley sites are most closely tied up with Naranjo and Caracol. In turn, the actions of kings from Naranjo and Caracol were affected by their position in wider political networks, as they, too, were swapping alliances and moving between the two even more influential 'superpowers' of Tikal and Calakmul, who maintained a mostly adversarial relationship with each another (Martin and Grube 2008).

Naranjo's early 'written' history is connected to the dynasty founded by *Yax Nuun Ayiin* (by AD 378) at Tikal/

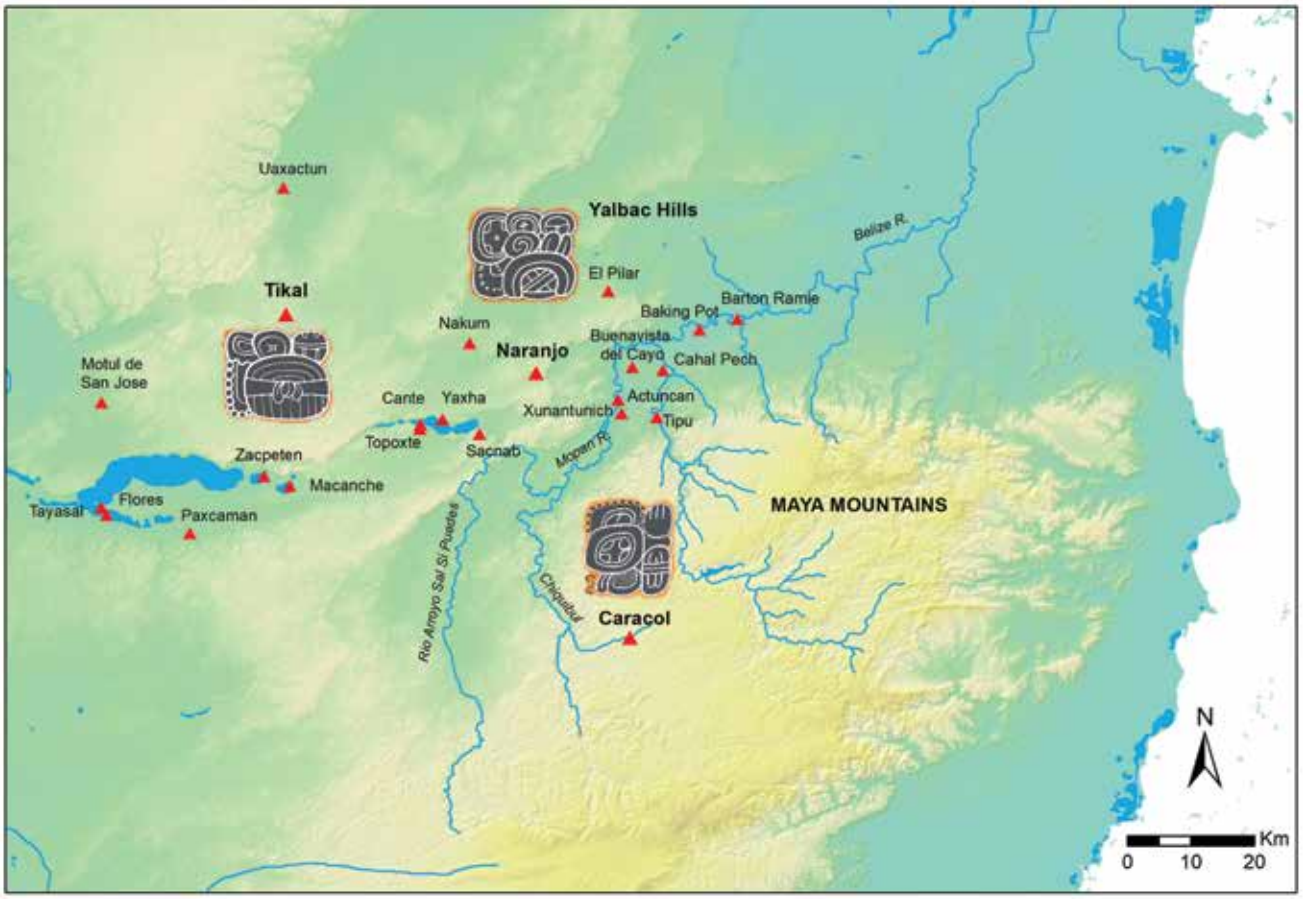


Figure 8.1. Map of eastern central Maya lowlands depicting locations and emblem glyphs of primary centres of Naranjo, Caracol and Tikal.

Uaxactun. One of the first historical rulers of Naranjo, *Tzik'in Bahlam* (around AD 450) was, according to stelae from Tikal, the maternal grandfather of *Chok Tok Ich'aak II* of Tikal (Martin and Grube 2008: 70; Tokovinine and Fialko 2007). About hundred years later, in AD 546, 'Aj Wosal' *Chan K'inich* began his reign and his accession was supervised by the king of the *Kanu'l* polity, which was instead associated at the time with Dzibanche (Martin and Beliaev 2017). 'Aj Wosal' (AD 546–615?) is one of the longest reigning kings of the Classic Period and his loyalty to the *Kanu'l* polity seemed to last throughout his reign (Grube 2006; Martin and Grube 2008). His accession is tentatively associated with Buenavista del Cayo's presumed rise to prominence within the Lower Mopan Valley, which took place at approximately the same time, given the previous connections between Buenavista and Naranjo (Peuramaki-Brown 2012). Although unclear, some sort of relationship with Naranjo is, at this time, also suggested for Xunantunich, based on the polychrome pottery that dates to the reign of 'Aj Wosal' *Chan K'inich* (Le Count and Yaeger 2010). The situation changes dramatically during the period following the death of 'Aj Wosal', sometime around AD 615. His successor *K'uxaj* was involved in conflicts with the regional adversary Caracol but also with the former ally Dzibanche (*Kanu'l*), indicating a change of Naranjo's political alliances by AD 631 (Martin and Grube 2008: 72).

It is sometime during this latter part of the Early Classic (circa AD 450–650), when we see Baking Pot appearing in the hieroglyphic record as well. The early dynastic title in the form of 'the ninth in succession' appears on a ceramic vessel recovered from a burial at an elite plazuela group at Baking Pot (Helmke and Awe 2012: 65; Conlon and Powis 2004). If this vessel proves to be of local origin (rather than an import to the site), it would be evidence that Baking Pot already had an established royal dynasty by the late Early Classic (Helmke and Awe 2012: 66).

The following king of Naranjo, *K'ahk'Xiiw Chan Chaahk*, defeats Caracol in AD 680, after which Caracol seems to fall into a serious political crisis that lasts almost 20 years (until AD 698). It is likely, however, that this victory did not last long and either Caracol achieved retribution or something similar happened, as *K'ahk'Xiiw Chan Chaahk* and his royal line disappear from the Late Classic political scene (Martin and Grube 2008: 73). There is not much evidence for contacts between the Naranjo and Central Belize at this period, and although this may possibly just be a matter of scarcity of evidence in general, it could well be that Naranjo was too preoccupied with fighting at this time and thereby did not maintain, or could not keep, its contacts with central Belize (Helmke and Awe 2012).

In AD 682, a new royal lineage is established at Naranjo with the arrival of Lady Six Sky, a princess from Dos

Pilas, whose family originated from Tikal, and once again under the auspices of the *Kanu'l*, now established at Calakmul (Helmke 2017; Helmke and Awe 2016). During her reign and that of her son, *K'ahk' Tiliw Chan Chaahk*, contacts with Central Belizean sites continue or, more likely, are re-established. At Xunantunich, this period is marked by considerable growth and reorganisation of the civic cores, which now emulate the cores of superordinate centres (Ashmore and Sabloff 2002; Ashmore 2010; Awe et al. 2020). Contact is indicated by a polychrome vase in Naranjo style found in a cave in the Macal Valley as well as Cabrito Cream-polychrome ceramics found at Xunantunich and Baking Pot (Reents-Budet 1994: 179–186; Helmke and Awe 2012: 76). Further evidence comes in the form of the 'Jauncy' vase from the Buenavista del Cayo, which originally was a possession of Naranjo's king, *K'ahk' Tiliw Chan Chaahk*, and later gifted to a member of Buenavista's royal family sealing the alliance (Houston, Stuart and Taube 1992; Reents-Budet et al. 2000: 117; Taschek and Ball 1992; Ashmore 2010).

The reign of *K'ahk' Tiliw Chan Chaahk* is marked by local military campaigns and efforts to expand Naranjo's sphere of influence. In addition to battling their large polity neighbour Tikal in AD 695, there is evidence of other campaigns: Stela 22 from Naranjo, which as Martin and Grube put it, 'reads like a conflagration of the eastern Peten', recounts further attacks and the burning of several other centres, including Bital (located between Naranjo and Caracol), Tubal (in the vicinity of Nakum), K'inchil Kab, Ucanal, Yootz, Yaxha, Sakha' (possibly a site near Lake Sacnab) and couple of other unidentifiable places (Helmke 2017; Martin and Grube 2008: 76).

The successful period during the reigns of Lady Six Sky and her son most likely ended with her death, possibly in AD 741 (her son *K'ahk' Tiliw* died earlier). In AD 744, during the reign of the successor, *Yax Mayuy Chan Chaahk*, Naranjo was attacked by Tikal under *Yik'in Chan K'awiil*, which resulted in the capture and execution of Naranjo's king and its second hiatus period (Martin and Grube 2008: 49, 76–78). The period after Naranjo's defeat is tentatively associated with the surge of public monumental construction at the site of Las Ruinas de Arenal in Central Belize (Taschek and Ball 1999: 232). It also correlates with Xunantunich's continuing growth and rise to prominence, when (by the end of the 8th century) it replaced Buenavista del Cayo as the regional centre (Taschek and Ball 2004: 203, Yaeger, 2010, Connell 2010, Yaeger et al. 2012). This is supported by the contemporary urban decline of Buenavista, with unfinished new construction projects, such as an incomplete *sacbe* (Peuramaki-Brown 2012).

This troubled period of Naranjo's history seems to last more than three decades, until a series of monuments were commissioned by the next Naranjo king, *K'ahk' Uk'alaw Chan Chaahk*, in celebration of the *k'atun* period ending 9.17.10.0.0 (AD 780). True in spirit to his militaristic grandmother Lady Six Sky and his father *K'ahk' Tiliw*, he records the attack and burning of Bital, a site previously burned by his grandmother, and another similar event a few years later. In fact, he also follows another family tradition: since his own mother, *Ix Unen Bahlam*, came to be united with his father after the capture of Tubal, so likewise he married Lady Shell Star, drawn from the royal house of Yaxha after conquering that site (Martin and Grube 2008: 76–81).

These renewed expansionist efforts are further attested at Baking Pot, where a miniature vase, possibly a gift to a local lord, bears Naranjo's ethnonym *Wak Kab'nal Winik* 'Six Earth-place Person' and a much eroded name, possibly that of *K'ahk' Ukalaw* (Helmke and Awe 2012: 76). Furthermore, a short glyphic text referring to Naranjo was found, inscribed over the throne in a room of the palatial structure at Cahal Pech. It dates to the Late Classic period (circa AD 700–800), names the above-mentioned ethnonym and Naranjo's particular dynastic title *Sak Chuwe'n,* and refers to a royal accession, possibly of the lord from Cahal Pech (Helmke et al. 2003; Helmke and Awe 2012). In comparison to Naranjo's interests and connections during his father *K'ahk' Tiliw's* reign, which seemed to be directed more to the south towards Caracol, *K'ahk' Ukalaw* once more turns his attention to Central Belize, extending his sphere of influence to the east (Helmke and Awe 2012: 76).

Naranjo's history continues with *K'ahk' Ukalaw's* son 'Itzamnaaj' *K'awiil's* accession to throne in AD 784. Despite his mother being from a Yaxha royal family, he wages war against Yaxha and its satellites in AD 799, probably kills the king and possibly even marries his widow, or some other relative (Helmke et al. 2020; Martin and Grube 2008: 83). The dynastic history of Naranjo ends with the last known king, *Waxaklajuun Ubaah K'awiil* and what may be the latest monument: Stela 9. Although without dates, it has been, based on its multi-figure composition, placed into Cycle 10 period (10.0.0.0.0), that is, after AD 830 (Martin and Grube 2008: 83). At the beginning of the Terminal Classic (AD 780–890), Xunantunich seems to gain one last advantage from the waning power of Naranjo and claims autonomy. This is indicated by the glyphic panel, dated to between AD 780 and 820 (Helmke et al. 2010: 101–107), including what is most likely Xunantunich's emblem glyph (Helmke and Awe 2012: 66–68).

Although 'less obvious and more intermittent', Caracol also maintains relations with Belize Valley (Helmke and Awe 2012: 80). The lesser visibility of these contacts might be partly due to Caracol's lack of ceramic workshops focusing on inscribed polychrome pottery, which would have been gifted (though see Helmke et al. 2018; Martin 2008). We have seen above that it is mostly these that provide the evidence of contact between Belize Valley sites and Naranjo (Helmke and Awe 2012: 80, Houston 1987: 97). Additionally, Caracol is located much further away from the Belize Valley than Naranjo (Caracol is circa 35 km south of Xunantunich while Naranjo is only 13 km west of Xunantunich).

For Caracol, evidence of these contacts comes from a different source. Excavations at sites, such as Cahal Pech, Pacbitun and Baking Pot, produced a specific type of caches (i.e., 'finger-bowl' caching) and funerary attributes normally associated with ritual practices observed at Caracol (Chase 2004: 328–330; Healy et al. 2004a: 214–215; Iannone 2005: 32; Helmke and Awe 2012: 80–82). Given the dates of these features, such as slate capstones dated to AD 550–700 from Pacbitun (Healy et al. 2004a: 214–215) and dedicatory caches discovered during the excavation of the causeway terminus structure at Baking Pot, containing a large number of ceramic vessels dating to the early part of the Early Classic and typologically associated with Caracol's ceramic assemblage (Audet and Awe 2004: 55–56; Awe and Helmke 2005: 44; Helmke and Awe 2012: 81), they indicate interactions between the Caracol and Belize Valley sites in the Early Classic and the middle of the Late Classic (Helmke and Awe 2012: 83). The Early Classic contacts are further supported by the glyphic reference found on the ceramic vessel from Baking Pot. The inscription names the ancient owner of the pot as *Yohl K'inich* (Colas et al. 2002: 37), a type of name most prevalent at Caracol (Martin and Grube 2000: 86–99; Helmke and Awe 2012: 81–82).

8.2.3. Northern Yucatan Peninsula

Hieroglyphic texts from the northern Maya lowlands sites are much scarcer than from their southern lowlands neighbours, therefore, our understanding of the political relationships between the sites is limited and skewed towards the sites with more texts. Much of what we know comes from inscriptions from Ek Balam and Chichen Itza, which between them share the majority of hieroglyphic texts in northern Yucatan Peninsula. Other important sites in terms of hieroglyphic records are Edzna, Xcalumkin, Oxkintok and Coba, and additional information can be sometimes gleaned from the much more limited textual evidence from several other sites across northern Yucatan, such as Acanceh, Dzibilchaltun, Halakal, Ichmul de Morley, Ikil, Itzimte-Sacluk and Uxmal.

Traditionally, the socio-political organisation of the northern lowlands was seen as different from that of the southern lowlands: less centrally organised, with many sites participating in a so-called *multepal* system or joint rule of lords holding the same status (Krochock 1998; Schele and Freidel 1990). Increased research in this region, accompanied by a growing number of known texts and their better understanding indicates, however, that many aspects of the social and political organisation of the northern lowlands polities were similar to those known from the southern lowlands during the Classic period. The *multepal* form of government was not as widespread as originally suggested and, based on new readings of y*itaj as* 'companion' (Boot 2005) rather than the previous 'sibling' (Stuart 1987; Schele and Freidel 1990: 360), some researchers recently argued that such form of government did not exist at Chichen Itza (Boot 2007: 138; Dahlin 2002; Cobos 2000, 2007) and even doubt that it ever existed. Inscriptions from sites such as Chichen Itza, Ek Balam and Dzibilchaltun contain emblem glyphs and royal titles like *k'alomte'* and *ajaw*, supporting the existence of a divine kingship and participation in hierarchical networks, in some cases, the same ones that the cities in the south participated in (for example, Coba and Yo'okop belonged to the *Kanu'l* sphere of influence, associated mostly with the site of Calakmul: Mercier and Cottini Giroldo 2014; Wren and Nygard 2005: 172–173; discussed in more detail below).

The similarity to the southern lowlands sites might be more applicable to some sites than others, however. Grube and Krochock (2007: 211) suggest that the northern plains and their sites, such as Dzibilchaltun, Ek Balam and Coba, were 'closer' to the southern lowlands than other Yucatan regions. Similarly, others suggest that northwest Yucatan differs from the east coast of Yucatan with regard to architecture (Gendrop 1983), ceramic complexes (Smith 1971), and in terms of iconography and writing (Proskouriakoff 1950; Grube 1994; Graña-Behrens 2002, 2006). Sites of the northwestern Yucatan usually have fewer texts or, at the very least, fewer carved monuments – some of them may instead have been painted and so if the texts existed, they did not survive. The remaining texts are generally shorter, using signs representing syllables rather than using both logograms and syllables, and they rarely contain any historical information (that is, births, deaths, accessions, period endings). Calendrical information is usually expressed by the 'Ajaw-count', rather than the Long Count, which is typical for the southern lowlands (Graña-Behrens 2002).

Ek Balam is located just east of this virtual border and it is called the 'last traditional kingdom of the Northern Plains' (Ringle et al. 2004: 514). This is visible in its scribal tradition, as Ek Balam's texts seem to be embedded in the southern lowland tradition, more so than some of the northwestern Yucatan sites (Grube and Krochock 2007: 208). Furthermore, the reign of Ek Balam's first king *Ukit Kan Le'ek Took'* (between circa 9.16.19.13.12 (AD 770) and 9.18.11.0.1. (AD 801)), temporally corresponds with that of several prominent Maya kings from southern lowlands sites, such as *Yax Nuun Ayiin II* at Tikal, tzamnaaj' *Bahlam III* at Yaxchilan, *Yax Pasaj Chan Yopaat* at Copan and Ruler 7 at Piedras Negras (Martin and Grube 2000: 22–23, cited in Grube and Krochock 2007: 208). Ek Balam's written history also reflects the existence of hierarchical relationships between sites. Inscriptions from Ek Balam and neighbouring sites indicate that Ek Balam dominated the political scene of the northern plains before the rise of Chichen Itza. Ek Balam's kings and nobles are mentioned in the texts of sites, such as Ikil and Ichmul de Morley, and the cessation of texts at Ek Balam closely corresponds with appearance of texts at Chichen Itza (Grube and Krochock 2007: 209–212). There are inscriptions at Chichen Itza referring to Ek Balam in a subordinated manner, suggesting that previously, Chichen Itza had been dominated by Ek Balam. Later on, however, after the rise of Chichen Itza, the Halakal lintel, which

dates to AD 870 (Grube, Lacadena, and Martin 2003: II–43) and is roughly contemporary with one of the earliest Chichen Itza inscriptions (from Casa Colorada), bears names of kings from both Ek Balam (*K'inich Juun Pik Took'*) and Chichen Itza (*K'ak' Upakal*). Similarly, the Yula lintels record the name of *K'ak' Upakal* and some other unidentifiable individuals (Grube and Krochock 2007: 228–229).

Further to the west, contact between the sites of Dizbilchaltun and Dzilam is indicated by the mention made to Dzibilchaltun's king, *Kalo'mte' Uk'uuw Chan Chaak* on Stela 1 at Dzilam (Grube 2003: 361–362), suggesting Dzilam's subordination to Dzibilchaltun (Grube and Krochock 2007: 210–212). At Yo'okop, the presence of the name Sky Witness, thought to be the name of a *Kanu'l* ruler, indicates a relationship between Yo'okop site and this southern lowland superpower (Wren and Nygard 2005: 172–173). Another northern lowland site that may have been drawn into the sphere of influence of the *Kanu'l* polity is Coba. Stela 30 from Coba records the enthronisation of Lady *Ixch'e'ennal* from the *Kanu'l* family of Dzibanche, who became queen at Coba in AD 565. She ruled independently for nine years and then she shared power with her husband *Wa? K'ahk' Bahlam* (Mercier and Cottini Giroldo 2014). On the other hand, mother of Ek Balam's king *Ukit Kan Le'k Took'* may have, according to Lacadena (2003) come from Coba.

Despite these rare examples above, the hierarchy between the northern lowland sites is often difficult to judge. Beyond the general scarcity of texts, other limiting factors include the scarcity and inconsistent use of emblem glyphs (Graña-Behrens 2006). There seem to be several variant forms of emblem glyphs in use, especially by northwestern Yucatan sites. Some of the variations would, by southern and central lowland standards, indicate a lower status or a different title altogether and can, therefore, be confusing. This inconsistency, according to Graña-Behrens (2006: 119), might indicate that emblem glyphs were most likely adopted from central and southern lowlands, rather than developed in the northern lowlands. Because they were not inherent to the region, the emblem glyphs might not have been assigned the same meaning and importance that they carried in the southern lowlands, expressing 'limitations in the ruler's authority' and therefore, perhaps, were used more flexibly (Graña-Behrens 2006: 119). This means, however, that even in cases where inscriptions include emblem glyphs, the hierarchy between the northern lowland sites and their rulers/nobles is more difficult to judge than that between their southern counterparts. Furthermore, texts from northern lowland sites rarely present historical individuals. For example, many nominal phrases found in the texts of Chichen Itza refer to deities, and there also seems to be much overlap between humans and gods in its inscriptions (Grube and Krochock 2007: 230). On the other hand, the few humans that are recorded in the texts, especially during the Terminal Classic, must have been exceptionally powerful and influential individuals, because at sites such as Uxmal, Dzibilchaltun and, to an extent Chichen Itza, inscriptions focus on the lives of very few and often just one single individual and his associates (Grube and Krochock 2007: 229). *K'ak' Upakal*, for example, appears in many Chichen Itza's texts over a period of 21 years (AD 869–890), his activity spanning most of the period of Chichen Itza's inscribed history (Grube and Krochock 2007: 229; although it has been suggested that there might have been two different namesakes: Guenter 2014: 104; and some have even gone as far as to suggest that *K'ak' Upakal* was not a real historical character: Graña-Behrens 2006: 117).

In addition, unlike the southern lowland texts, which emphasise descent through the male line and focus on male ancestors, the northern lowland texts, especially those from Chichen Itza, seem to be focusing on female descent lines (Grube 1994; Krochock 2002; Grube and Krochock 2007: 224–225). Grube and Krochock (2007: 223) suggest that this might be because of the foreign origin of Itza men, who came to Chichen Itza through coastal trade and who, in order to be able to 'participate in the ruling class', had to marry women from prestigious local families.

8.3. Changes in the written records from the Classic to the Postclassic period

Whereas the cultural and political history of the Classic period is quite well documented, the transition between the Classic and the Postclassic period is not. One reason is the significantly decreased number of Terminal Classic inscriptions and almost complete lack of Postclassic ones. However, via increased archaeological exploration of this transitional period, the Terminal Classic has slowly begun to resurface in Maya studies. What follows is a brief exploration of the changes we can see in the epigraphic record between the Classic and Postclassic period in the two case study regions.

In view of the often-considerable changes taking place between the Classic and Postclassic period in the Maya area (some of which are described in previous chapters), we would expect to see at least some consequences of these changes in the hieroglyphic texts. There are many expressions of crisis, for example, in later Maya literature. The Chilam Balam books, written mostly during the 17th and 18th century (for example, Chilam Balam of Chumayel: Roys 1967: 122; Edmonson 1986; Bricker and Miram 2002) and the Dresden and Paris Codex dated to the 12th and 13th centuries (Love 1994; Houston 1997; Grube 2012) talk about crises or periods of stress as being omnipresent. Their *k'atun* prophecies all frequently mention hunger, drought and war. Surprisingly, there is no mention of collapse, population migration or any other crisis in the hieroglyphic inscriptions, except for two references to the proposed drought in the Classic period texts. The first comes from a burial urn found at the site of Comalcalco (Armijo and Zender 1999; Armijo et al. 2000) and the second is from the Central Tablet from the Temple of Inscriptions at Palenque (Lacadena 2006; Guenter 2007: 32; both are discussed in more detail below). Does

this mean that there was no crisis, no change to write about in the transition from the Classic period and Postclassic period? Can some transformations still be seen indirectly from changes in iconography, changes in emphasis on certain topics and silence on others? In this section, the aim is to look at the written records mostly from the Late Classic and Terminal Classic Period, to see if such changes can be detected and if so, what we can learn from them.

Four different changes are perceivable in Maya hieroglyphic inscriptions that will be briefly discussed:

(a) a change in the focus of the Terminal Classic texts from the description of martial actions to an emphasis on rituals, indicating a narrative shift and increasing disjunction between what is actually taking place and what the texts relate,
(b) a change in the composition of stelae from featuring the single ruler, often standing on a captive in position of power, to multi-figural 'conversation' scenes, often involving subsidiary governors and officials of the royal court without symbols of royal status and power,
(c) the dedication of carved monuments by rulers at secondary centres, who are appropriating the emblem glyphs of other, formerly primary centres and claiming the title of the *k'uhul ajaw*, and lastly,
(d) an iconographic and stylistic change.

8.3.1. Change in the focus of the Terminal Classic texts

The texts from the Classic period (AD 250–800) are renowned for their commemoration of the passing of time and were focused on the deeds of kings, including royal births, enthronements, marriages, rituals and wars. In contrast, Terminal Classic texts (AD 800–950) are essentially mute on warfare and social upheavals, although the iconography and figurative elements of the monuments retain militaristic themes and archaeological evidence indicates that warfare and social restructuration was pronounced at this time (see Okoshi et al. 2021). Instead, ritual continuity is constantly emphasised via the proper perpetuation of key ceremonies. Several monuments from the Terminal Classic period mention gatherings of rulers from different sites, performing rituals together (Grube 1994; Martin and Grube 2008; Helmke et al. 2010). Such joint rituals are mentioned taking place at Ucanal and Seibal, involving lords from Caracol, Naranjo, Tikal, Calakmul and Motul de San José (Grube 1994: 93–97; Martin and Grube 2008: 53, 83, 99, 115, 227; Helmke et al. 2010: 210). Xunantunich's monuments seem to be describing similar events: Stela 8 mentions a ritual being performed by both the lord from Xunantunich and Naranjo's king *Waxaklajun Ubah K'awil* (Helmke et al. 2010: 120). Similarly, Copan's ruler *Yax Pasaj Chan Yopaat* joins period-ending celebrations at Quirigua (Martin and Grube 2008: 224–225). Interestingly, based on earlier texts, some of these centres would involve former adversaries, centres belonging to different political and military alliances (for example, Tikal and Calakmul). These texts, however, instead of highlighting military actions and conquests, seem to focus on renewing or, in some cases, forging new alliances, perhaps in an effort to 're-establish the political networks that provided relative stability in the Early and Late Classic periods' (Helmke et al. 2010: 210).

It is not only the joint rituals that these texts mention, however. The rhetoric of the Terminal Classic texts seems to be preoccupied with ritual activity in general (Grube and Krochock 2007; Helmke at al. 2010). For example, Terminal Classic monuments from southern and central lowland sites, such as Jimbal (Stela 1 and Stela 2), Ixlu (Stela 1 and 2 and Altar 1), Tikal (Stela 11 and 24), Caracol (Stela 11 and 17 and Altar 12), Seibal (Stela 10, 11 and 19), Tonina (Monuments 104, 158), Uaxactun (Stela 7 and 12), Ucanal (Stela 4), Quirigua (Stela I and K and Structure 1B), Nimli Punit (Stela14) and Itzan (Stela 6), all dating to between AD 800 and 904, contain either written or iconographic expressions of ritual activity, often related to period endings (the end of important periods in the Maya calendar, usually *k'atun*, a 20-year period) (Helmke et al. 2021). In these specific cases, the texts mention either scattering or so-called 'bathing' rituals (both discussed in the case study below), usually performed by a king, who in some cases is accompanied by, or sometimes impersonating, a Maya deity or deities. The lack of historical information, with, rather an emphasis on ritual is even more pronounced in texts from the northern lowlands. In the bottom register of Stela 9 from Oxkintok, two figures are involved in some kind of ritual activity, with one figure dancing. Similarly, on Stela 12, two of its four registers depict a pair of figures performing rituals, one of them most likely involving incense burning and the other possibly depicting a fire-drilling ceremony. Similar scenes can be found on monuments from Chichen Itza. In fact, there seem to be two thematic groups prevalent in Chichen Itza's inscriptions. The first group describes ritual activities, such as fire-drillings and other fire rituals, the conjuring of visions, and autosacrifice/blood-letting; and the second group expresses dedication of buildings and architectural elements (Grube and Krochock 2007: 230).

Another interesting feature in the Terminal Classic texts, especially from some northern lowland sites such as Chichen Itza, is the comparative focus on deities and the overlap between the humans and gods. Grube and Krochock (2007: 230) noticed that it is often difficult to distinguish between the humans and supernatural figures in the inscriptions of Chichen Itza. They suggest that for the people of Chichen Itza, such a distinction might not have been that important. 'They probably would have been able to recognize the different features of gods and humans, but they would have recognized divinities as co-rulers, who sat next to the lords and protected them, gave away some of their power, and communicated with the humans who ruled the city' (Grube and Krochock 2007: 230). Many of the nominal phrases belong to gods explicitly, with one of the most prominent gods being the rain god *Chaahk*, appearing in Chichen Itza and Yula's texts (Lacadena 2004). The focus on gods instead of humans becomes even

more prominent during the Postclassic period, especially in scenes on murals depicting Maya deities associated with rain, maize, abundance and commerce (Taube 1992: 9; Kepecs 1999: 491; Valencia Rivera 2019).

Nikolai Grube (2013) suggests, following the temporal distribution of these changes, that AD 780–800 is a period of more obvious war narratives (for example, texts from Naranjo, Yaxchilan, Piedras Negras and Bonampak), while AD 800–850 involves a reconstruction of the 'old order', with former adversaries conducting rituals together and visiting each other (for example, Caracol and Ucanal, Tikal and Calakmul, Seibal, Altar de Los Reyes). In contrast, AD 850–910 involves reference to period endings and rituals (for example, Ixlu, Jimbal, Xunantunich, Machaquila, Uaxactun, Tonina and Chichen Itza). These shifts in what the texts focus on over time were also accompanied by changes in stelae composition, style and iconography, and the appearance of emblem glyphs and royal titles at formerly secondary centres (discussed below).

If this very hypothetical view is to be accepted, then there is a rhetorical shift and increasing disjunction between what is actually taking place and what the texts relate, which leads to two main questions: (a) why does this narrative change appear at this time, and (b) what was the nature of the rituals the texts are focusing on? In order to attempt to answer these questions, the later part of this chapter presents results of a case study focusing on two particular kinds of rituals appearing in Terminal Classic texts: one involving the 'scattering' of precious substances and the other the 'bathing' of a particular pair of deities. By examining the temporal and spatial distribution of these rituals and comparing them with climatological evidence, the study explores the association between these rituals and droughts and seeks to clarify one facet of human responses to environmental stress.

8.3.2. Stelae scene composition: from captive-taking to conversation

As mentioned above, one of interesting trends in the Late Classic and Terminal Classic stelae is the change in stelae composition and more frequent appearance of non-royal elites, such as subsidiary governors and titled courtiers, both in the texts and in iconography (Stuart 1996; Houston and Stuart 2001). Stelae dating to the end of the Late Classic and Terminal Classic start to show scenes in which the ruler is accompanied by individuals of high status, indicated by both the dress and their interaction with the ruler. This 'multi-figure composition' is, according to Martin and Grube (2000: 83), 'typical of Cycle 10' – the period after AD 830 (see also Grube 2004: 210). For example, Stela 9 from Naranjo features multiple figures and is strikingly different from other Naranjo monuments in which the single ruler is the centre of the scene and in the position of power, holding a ceremonial bar, spear and shield, or standing on a captive (Fig. 8.2). It is, therefore, thought to be later than the Stela 32, which is the last dated monument, dedicated by *Waxaklajun Ubah K'awil* in AD 820 (Helmke et al. 2010; Savchenko 2015). In many of these multi-figure scenes from Central Peten, people are depicted seating and perhaps conversing (for example, Caracol, Fig. 8.3). In some cases they are simply dressed, without any obvious signs of royal regalia and status, which, as Rice and Rice (2004: 133) suggest, might reflect the effort not to flaunt symbols of status and power. They also observed that the conversational and diplomatic scenes often appear on Terminal Classic moulded-carved vessels (Helmke 2001; Helmke and Reents-Budet 2008; Rice and Rice 2004: 133–134; Ting 2013) and suggest that these vessels might have been used for serving food and drinks during such gatherings (Rice and Rice 2004: 133–134). A similar pattern is observed in the northern lowlands. Multi-figural, conversational scenes appear at sites such as Chichen Itza, Halakal, Mayapan, Oxkintok. For example, Oxkintok's Stelae 3 (AD 849) has multiple registers, with the middle register depicting two figures sitting across from each other, most likely engaged in conversation (Fig. 8.4). Apart from the larger headdress of the person sitting on the left, there is no obvious indication of status differences between the two figures. Similar scenes with individuals engaged in various activities, of seemingly equal status, in Chichen Itza's inscriptions (Krochock 1991) led to the suggestion that a shared form of governance, or a *multepal*, was employed instead of divine kingship (Schele and Freidel 1990; Grube 1994; Grube and Krochock 2007: 220) but, as we have already seen, this model is highly problematic and unfounded.

This presence of non-royal elites, such as subsidiary governors and titled courtiers, or people of unrecognisable status in later inscriptions is, at least in the southern lowlands, further complemented by the claims for autonomy of secondary sites.

8.3.3. Independence claims by secondary centres

In the second half of the 9th century, we begin to see, in formerly secondary centres, the appearance of carved monuments commissioned by rulers using the royal title of *K'uhul Ajaw* and the emblem glyph of the centre under which the secondary centres were previously subordinated. For example, Altar 1 of the small site of Ixlu, located close to Tikal, was dedicated on a date 10.2.10.0.0 (AD 879), by a ruler who called himself *K'uhul Ajaw* and used the Tikal emblem glyph; ten years later, the title of *K'uhul Ajaw* of Tikal appears on Stela 2 from Jimbal (also in Tikal's vicinity)[21], and on Stela 6 from the more distant Xultun (Schele and Freidel 1990: 391; Valdés and Fahsen 2004: 151). The text from Xultun (AD 899) is, in fact, the last known glyphic reference to Tikal (Valdés and Fahsen 2004: 151). Interestingly, in the case of the Ixlu and Jimbal stelae (St. 1 and 2 from Ixlu, AD 859 and 879 respectively, and St. 1 from Jimbal, AD 879), were commissioned in a distinctly similar style to Tikal stelae, however, Tikal's emblem glyphs are only mentioned on the latest monuments

[21] The Tikal emblem glyph possibly also appears on Zacpeten Altar 1, although it was dedicated slightly earlier in AD 849 (Stuart, 2009).

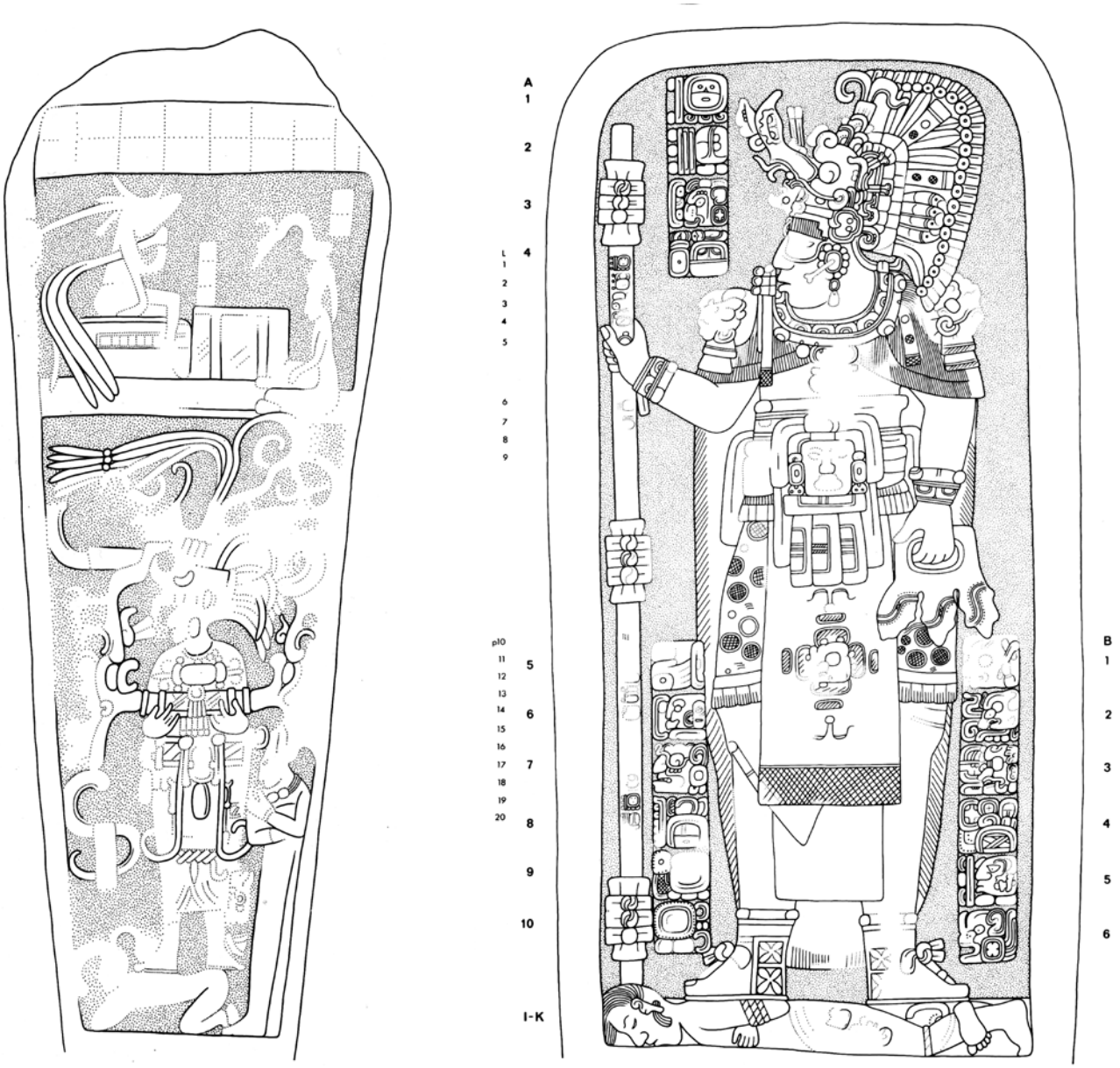


Figure 8.2. Naranjo Stela 9 – multi-figural composition versus Naranjo Stela 30 – ruler in position of power (Drawings by Ian Graham © President and Fellows of Harvard College, Peabody Museum of Archaeology and Ethnology, PM 2004.15.6.2.17 and PM 2004.15.6.3.10).

(Altar 1 at Ixlu, AD 879 and Jimbal St. 2, AD 889). These declarations of independence have been interpreted as a power-sharing mechanism used by Tikal, where seats of ceremonial performances were shifting between secondary sites (Schele and Freidel 1990). Guenter, on the other hand, argues that the fact that these monuments are not contemporary but appear on different dates might suggest shifting of a royal court between these sites, 'from Tikal, to Zacpeten, to Ixlu, with a final, abortive attempt to refound Tikal as a royal centre in the mid-ninth century, before a final retreat to Ixlu' (Guenter 2014: 321). Guenter (2014) also argues that the movement of the royal court between the sites was in response to drought (movement to defensible places on bodies of water), rather than reflecting a breakdown of centralised authority.

Not all of these independence-claiming monuments can be explained by the shifting of royal courts, however, because some of these centres start to use their own emblem glyph. One such example comes from Nakum where, at the beginning of the Terminal Classic period (AD 815), Stela 1 was erected with text commemorating a *hotun* (five-year period ending) and mentioning a scattering ritual being performed at this occasion (Źrałka et al. 2018). The ruler's name is followed by Nakum's emblem glyph and title of *K'uhul ... Ajaw,* indicating Nakum ruler's claim to independence and full power over Nakum. According to Źrałka (2008:203), it is the first and only epigraphic evidence of the *K'uhul Ajaw* title being used at Nakum. Interestingly, Stela 2, the last dated stela at Nakum and in the whole of the Triangulo Park area (an area that includes the sites Nakum, Yaxha and Naranjo), dedicated in AD 849, contains another prestigious title: *ochk'in kaloomte'* (Źrałka 2008: 203). This title was one of the most prestigious elite titles during the Early and Late Classic periods. Curiously, it seems to become relatively

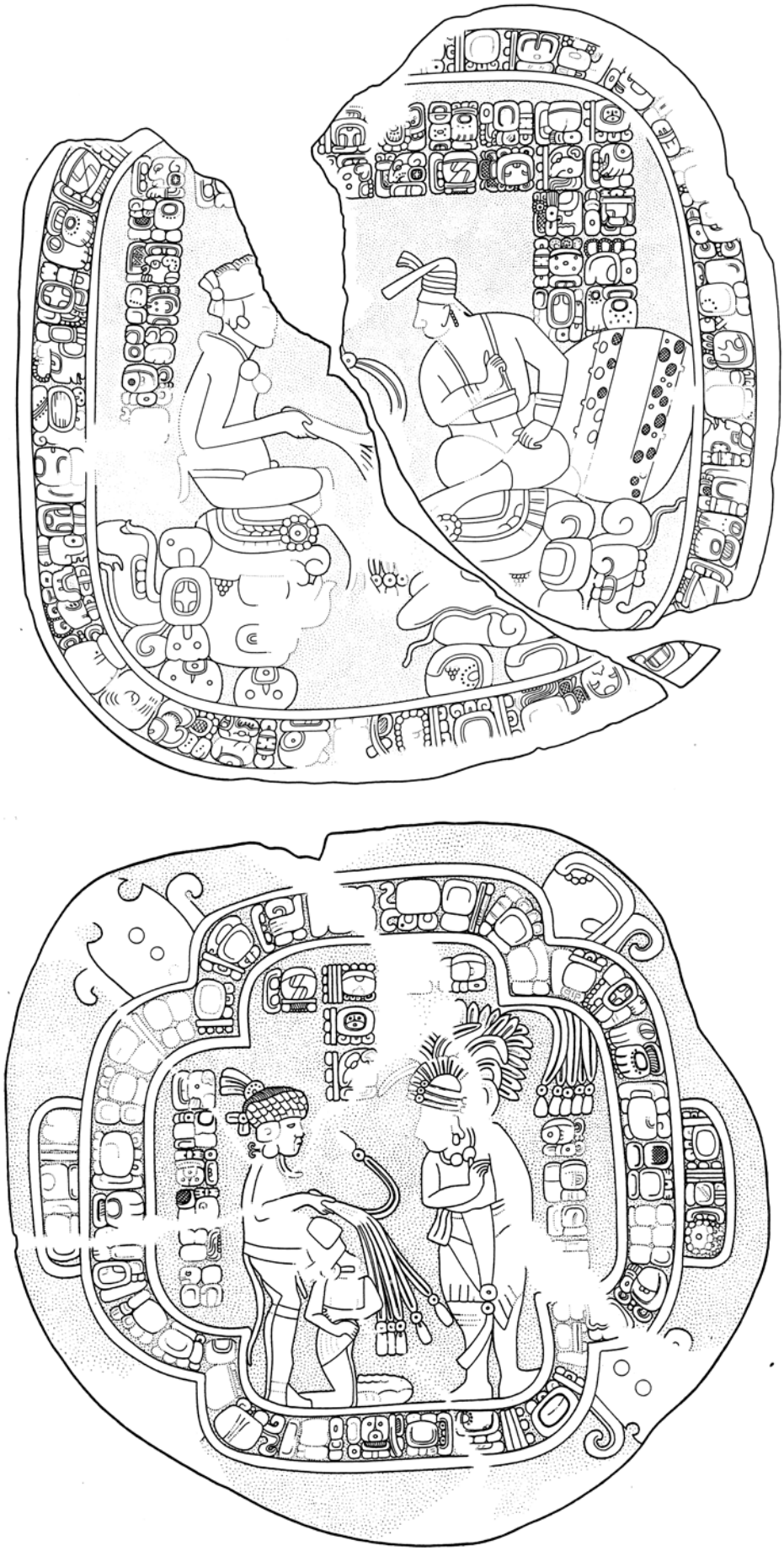


Figure 8.3. Caracol, Altar 12 (AD 820) and Caracol, Altar 13 (AD 820) (Copyright Nikolai Grube, Pre-Columbian Art Research Institute, 1994).

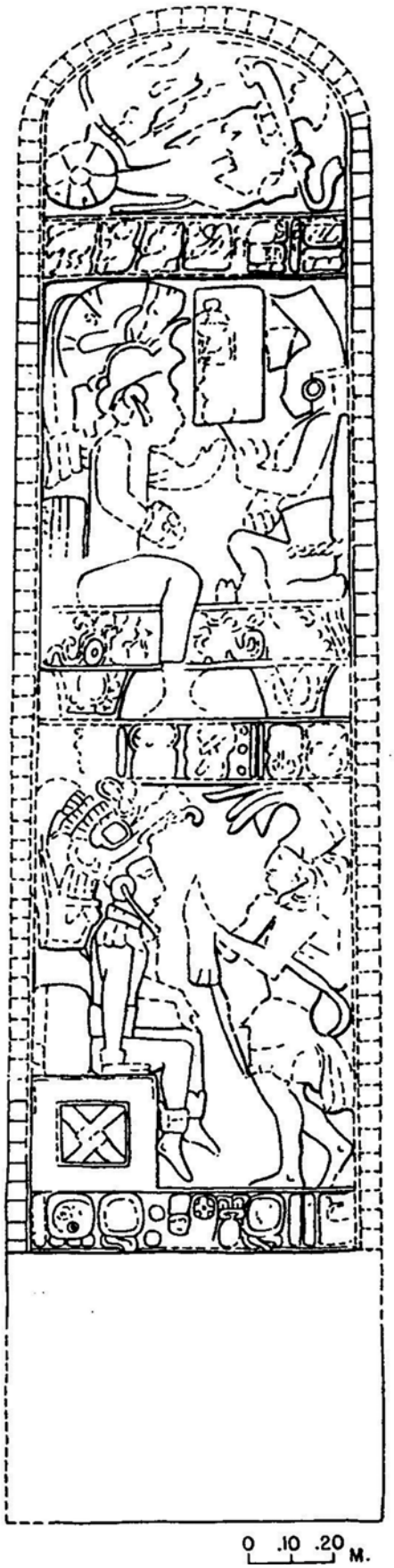


Figure 8.4. Oxkintok, Stela 3 (Reprinted by permission from H. E. D. Pollock, The Puuc: An architectural survey of the hill country of Yucatan and northern Campeche, Mexico. Peabody Museum of Archaeology and Ethnology, Harvard University, (Cambridge, MA, 1980), figure 544b).

widespread and popular during the Terminal Classic period, however it is possible that by this time, its use and status may have changed.

Claims of autonomy at the beginning of the Terminal Classic may be also indicated by Panel 2 from Xunantunich (ca. AD 780–820), as it contains what is most likely Xunantunich's emblem glyph (Helmke et al. 2010: 101–107; Fig. 8.5). A similar situation seems to have existed in the vicinity of Calakmul, where small secondary centres dedicated stelae during the 9th century AD. Stela 7 from Oxpemul, for instance, was commissioned to celebrate the *k'atun* ending, and dates to 10.0.0.0.0 7 Ajaw 18 Zip (11 March AD 830). It is the latest Initial Series date known at Oxpemul (Robichaux 2010). It contains the emblem glyph of Oxpemul with the *ajaw* sign indicating the person named on a stela as a lord of Oxpemul (Robichaux 2010: 64). Another two stelae (Stela 13 and Stela 1) were dedicated at the site of La Muñeca and date to AD 879 and 889 respectively. These stelae exhibit the same dates as the monuments from Ixlu and Jimbal, illustrating another interesting feature of Terminal Classic monuments. As mentioned above, after the Classic period, the non-round historic dates decrease in frequency and monuments with round, period-ending dates, focusing mostly on ritual activity, predominate (Helmke et al. 2010; Helmke et al. 2021).

If a similar situation with independence claims existed in the northern lowlands, it is more difficult to detect. As mentioned at the beginning of the chapter, the limited number of sites using the emblem glyphs and their inconsistent use could indicate that they may have carried less meaning and importance (Graña-Behrens 2006), and therefore possibly may not have been employed in the same manner to claim autonomy as in the southern lowlands. It is possible that the political organisation of northern lowland sites was 'looser', with sites being more independent from each other in comparison to those in the southern lowlands, which belonged to complex hierarchical networks of alliances and vassalhoods.

8.3.4. Iconographic, stylistic and linguistic differences

Going back briefly to the conversational scenes on ceramics and on stelae, discussed above, Don and Prudence Rice suggest that in Central Peten, these scenes could reflect the Terminal Classic migration of 'foreign' people into Peten, who might have been 'peacefully assimilated and perhaps even welcomed' (2004: 133–134). The multi-figure composition and division of the scene into multiple registers on Stela 9 from Naranjo and on Stela 3 from Seibal, indicate stylistic parallels with carved monuments from the northern lowlands (for example, Mayapan Stela 1, Oxkintok Stelae 3, 9 and 12 and several Chichen Itza monuments; Rice and Rice 2004; Źrałka 2008: 198–199). These northern features (also appearing on Terminal Classic stelae at other southern lowland sites, such as Ucanal, Ixlu and Jimbal), indicate close relations between the two regions during this time (Źrałka 2008: 198–199),

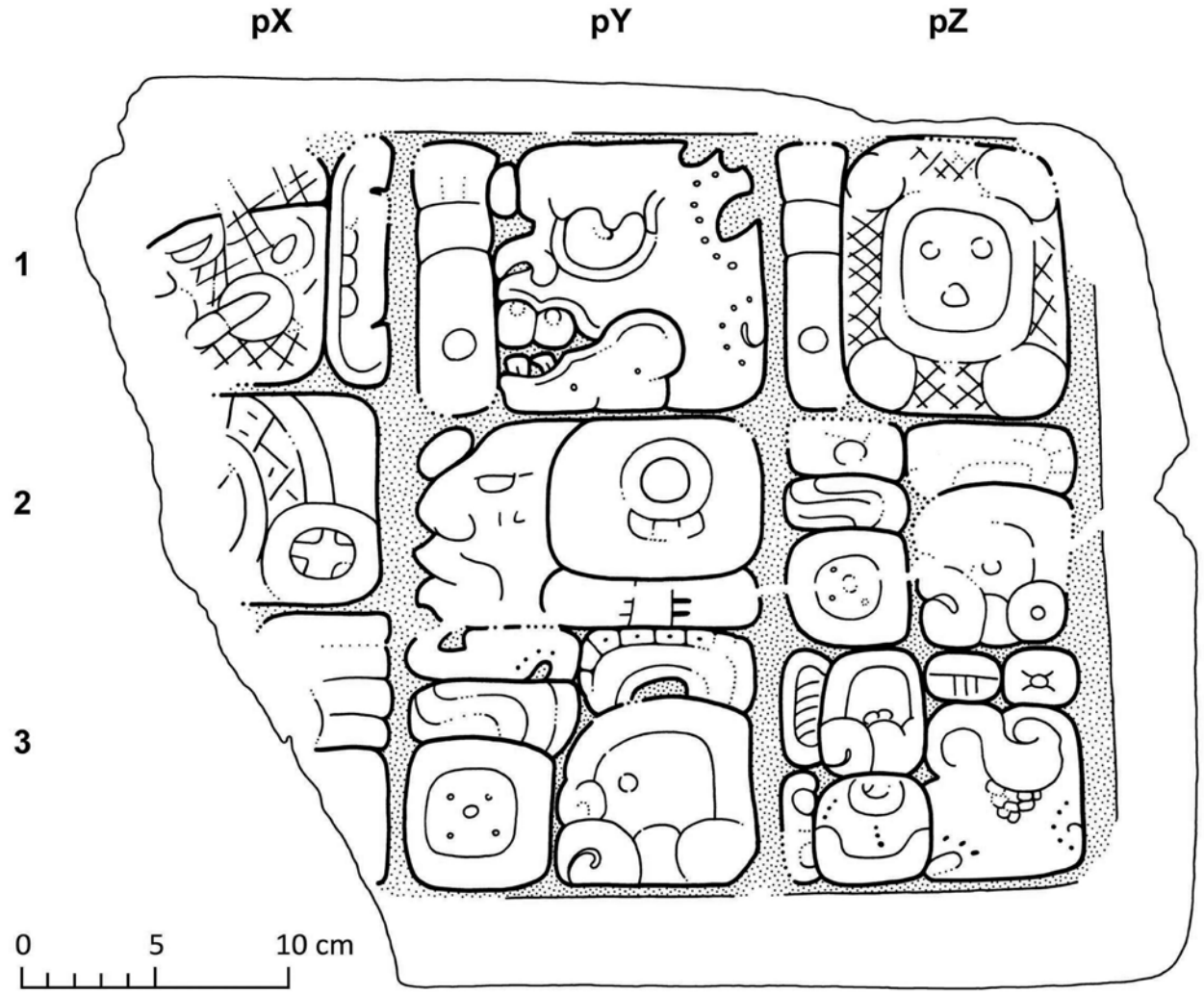


Figure 8.5. Panel 2 from Xunantunich with the site's likely emblem glyph (drawing by Christophe Helmke).

and they are also observable in the archaeological record, such as architectural styles and ceramic materials (Rice and Rice 2004), as well as in iconographic changes, for example in murals (see Miller 1982, 1985).

Another difference observable in Terminal Classic texts, particularly those from Chichen Itza in the northern lowlands is 'the introduction of linguistic forms that are closer to the Yucatec language than to the Classic Mayan language of Cholan origin which was used at Ek Balam' (Grube and Krochock 2007: 215). Although in this case, Grube and Krochock (2007:216) argue that rather than stressing the relationship with other areas, Chichen Itza scribes are emphasising their difference and linguistic independence. Similar independentist tendencies are reflected in their ceramics, which no longer show ties with the southern lowlands (Cobos 2004: 520; Grube and Krochock, 2007: 242).

The monuments indicate foreign influences from other areas as well, however. Based on the considerable evidence of interaction between the cultures from southern Veracruz and the Maya populations in Tabasco, it was suggested that elites became bilingual, speaking both Nahua and Chontal languages (Carmack 1981; Justeson et al. 1985: 69; Lacadena 2010; Vargas 2001: 49; Pallan 2012). Influences from Tabasco and southern Veracruz are reflected in square-shaped day-sign cartouches, merchant iconography and moulded/sculpted fine paste ceramics (Andrews 1990: 261; Wyllie 2002: 305). These distinctive square-shaped day-sign cartouches are incorporated into Terminal Classic texts at sites such as Ixlu, Jimbal, Ucanal and Seibal (Fig. 8.6). These foreign, or non-Classic features, were seen by some researchers as an indication of invasion and were, especially during 1960s and 1970s, linked to the Classic Maya Collapse (see, for example, Sabloff and Willey 1967; Sabloff 1973).

In addition to the the focus on the Feathered Serpent imagery, foreign influences are represented by military symbolism and its emphasis on commerce, including merchant aspects of the God L (Pallan 2012: 103), predecessor of the Postclassic main trade god *Ek Chuwaaj* (Taube 1992: 84–88). A relatively wide geographic area, spanning from the Puuc region to Central Mexico and encompassing parts of Veracruz and the Mixtequilla region in the Gulf Coast, shares continuities in iconographic motifs pertaining to this trading deity (Taube 1992;

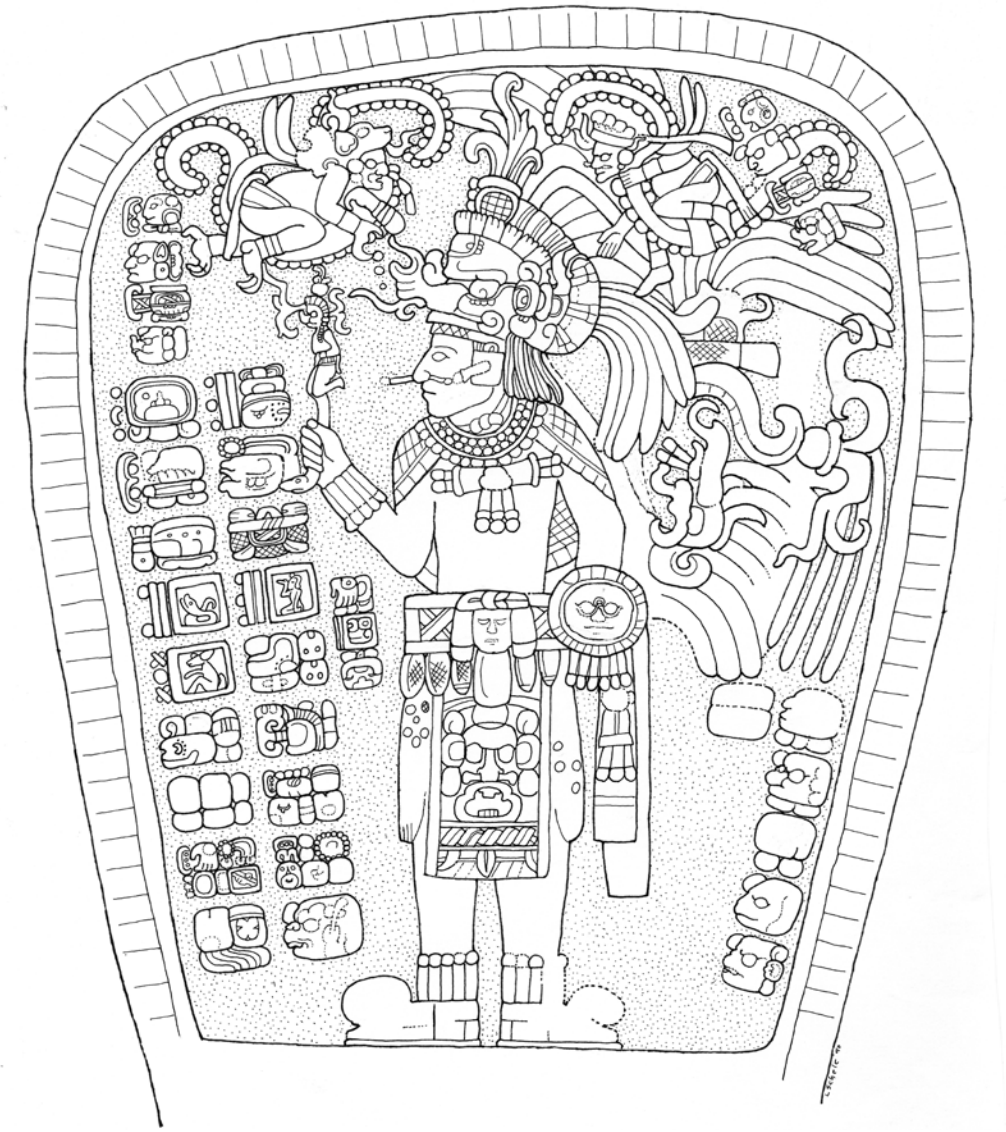


Figure 8.6. Jimbal Stela 1, with distinctive square-shaped day-sign cartouches indicating Mexican influence (Drawing by Linda Schele © David Schele, Photo courtesy Ancient Americas at LACMA (ancientamericas.org), SD-2029).

Martin 2006 cited in Pallan 2012: 103). The emphasis on commerce and its growth is also reflected in shrines placed along Yucatan's coastal routes, facing the sea at sites such as Cozumel, Playa del Carmen, Paamul, Xcaret, Akumal, Tancah, and Tulum (Andrews IV and Andrews 1975; Lothrop 1924). Furthermore, scenes on murals (for example, Santa Rita; Taube 1992: 9) depict *Ek Chuwaaj* and other Maya deities, such as God D, creator of life and abundance and God K, associated with rain and maize (Lothrop 1924: 52; Taube 1992: 37, 76–79; Quirarte 1982 cited in Kepecs 1999: 491), which, although not directly linked to commerce, 'may be present in these scenes to sanctify mercantile activities and signal the divinity of their pursuit' (Kepecs 1999: 491).

Some researchers argue that that these 'new' iconographic elements, such as the Feathered Serpent imagery (and architectural elements, such as round buildings) are not new, and that many of them had long been part of Maya imagery (Pendergast 1986; Masson 2000: 19). Likewise, Maya trade goes back to the Preclassic period (Rice 1984; Aoyama 2001; Braswell et al. 2011; Graham 2011; Golitko and Feinman 2015). Iconographic, stylistic and linguistic differences, rather than a consequence of a 'new order', might simply be a response to changing cultural values in an increasingly 'cosmopolitan' society (involving people especially from the circum-peninsular communities) and growing importance of trade and commerce. Furthermore, as argued by Graham (pers. comm. 2016), increased trade and changing values might have encouraged warfare (access to goods, expansion of trade routes and resource control) and changes in the rules of engagement (Aoyama and Graham 2015).

8.4. Change in written records as a potential response to water scarcity

As discussed above, Terminal Classic texts show a narrative shift and disjunction between what was actually taking place and what the texts relate. Although archaeological

evidence indicates that warfare and social restructuration was pronounced at this time, the texts do not deal with topics, such as social unrest and warfare**,** but rather focus on ritual continuity and the proper perpetuation of key ceremonies. This dissonance gives rise to questions: Why does this narrative shift appear at precisely this time? What was the nature of the rituals performed? What do the texts and ceremonies tell us about the preoccupations of the Terminal Classic Maya? In this section, the hypothesis that the increased ritual focus of the Terminal Classic texts might represent a response to environmental stress will be explored.

The increasing amount and range of palaeoclimatic data collected during the last few decades indicates diminished precipitation, and even recurrent severe droughts, during the Terminal Classic period (Brenner et al. 2002; Leyden 2002; Rosenmeier et al. 2002; Wanner et al. 2008; Webster et al. 2007; Kennett et al. 2012). Such evidence undermines the widespread academic assumption of abundant water supply in the tropics. There are also frequent, but as yet, under-emphasised expressions of crises in later Maya literature. For instance, the prophecies recorded in the books of Chilam Balam, written mostly during the 17th and 18th centuries (Roys 1967:122; Edmonson 1986; Bricker and Miram 2002) and the Dresden and Paris Codices, dated to the 12th and 13th centuries (Love 1994; Grube 2012), mention hunger and drought with some frequency. Given these precedents, we might expect such phenomena to also be mentioned in earlier Maya hieroglyphic records and it, therefore, initially comes as a surprise that only two direct references to drought are found in the Classic period texts. The first comes from a burial urn from the site of Comalcalco, which according to its hieroglyphic texts, was the final resting place of a Maya priest named *Ajpakal Tahn.* His urn was richly furnished with jade jewellery, shark's teeth, carved shell and human bone pendants, obsidian blades, a flint eccentric, and stingray spines with glyphic texts as well as iconographic scenes (Armijo 1999; Armijo and Zender 1999; Armijo et al. 2000; Zender 2004: 250). One of the stingray spines bears a text that says rather bluntly: 'there was drought, there was famine in the thirteenth year' of this *k'atun* (Zender 2004: 257, 543), which, based on associated calendrical notations, places the drought in the latter half of the eighth century[22], depending on the preferred anchor and calendrical correlation chosen) (Figure 8.7).

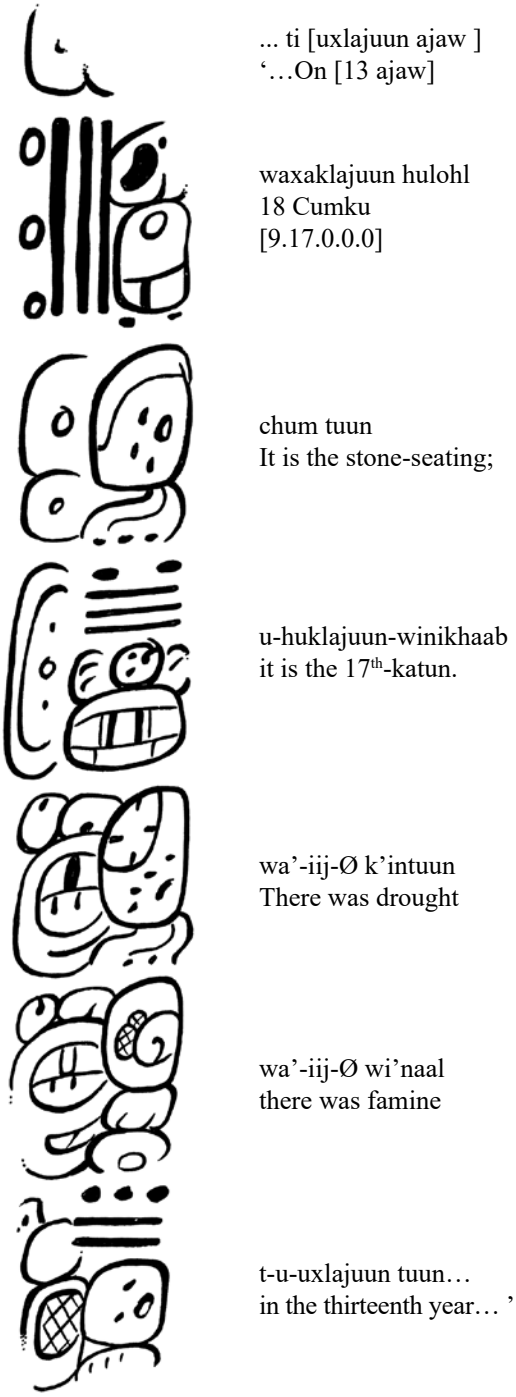


Figure 8.7. Inscribed Stingray Spine 3, of Urn 26 from Comalcalco, which records an event of drought and famine in AD 784 (drawing by Christophe Helmke after Zender 2004: 543, Fig. 73).

The second, prophetic rather than historical, reference comes from the Central Tablet of the Temple of Inscriptions at Palenque and may refer to a drying out or to 'withering' of the World Tree (Lacadena 2006; Guenter 2007: 32). These two texts therefore confirm a deeper history of drought in the region, although we might have expected a few more of such mentions. It is, therefore, worth asking: Are these two references to drought and famine all there are in the hieroglyphic record or are we overlooking some indirect evidence?

Considering human behaviour in reaction to drought and periods of climactic stress, one of the widespread responses is ritual activity, with rain-beckoning rituals being especially common cross-culturally. Below we therefore explore the written Classic Maya corpus of

[22] The text starts with a calendar round that can be anchored to the 17th k'atun, or the 9.17.0.0.0 Period Ending, corresponding to AD 771. The mention of the 'thirteenth year' can be interpreted in two ways: either that this is 9.17.13.0.0 or AD 783, (which we prefer), or alternatively as a date within the 17th k'atun, which is to say 9.16.13.0.0 or AD 763 (Zender 2004: 257; see also Guenter 2014: 286).

glyphic texts, focusing on two particular rituals, one involving the 'scattering' of precious substances and the other a 'bathing' ritual involving a particular pair of deities. These two rituals, which predominate in the Terminal Classic period, were chosen based on the hypothesis that these two rituals were closely related to the agrarian lifecycle, respectively symbolising the act of sowing and the invocation of rain-bearing clouds. As such, these may have originated in response to fears about water scarcity or be closely associated with periods of diminished precipitation. By examining the temporal and spatial distribution of these rituals and comparing them with climatological evidence, this case study explores the association between these rituals and likely droughts.

8.4.1. Rain-beckoning rituals

The topic of 'rain-making' has long formed a part of anthropological literature (see for example, Frazer 1911; Butree 1930). Some of the best-known rituals and rain-making acts include the North American rain dances, but also blowing smoke to imitate clouds, performed historically and still today, by many Native American tribes especially in the Southwest (for example, the Zuñi or Hopi; Butree 1930; Stevenson 1904: 21). In fact, many parallels in religious practices, and rainmaking rituals in particular, have been noted between the American Southwest and Mesoamerica (see Parsons 1993; Brew 1943; Schaafsma 1999; Taube 2000; Schaafsma and Taube 2006). Some of the traits, such as directional rain deities associated with cardinal directions or the association of smoke with cloud-making, have been argued to be ancient Mesoamerican concepts, most likely developed by Olmecs in the Formative period (Thompson 1970: 269; Wrem and Helmke 2013), which were later adopted by cultures of the Southwest (Underhill 1948: 17; Schaafsma and Taube, 2006: 263). Early examples of these features in the Maya area are represented, for example, by the quadripartite rain god *Chaahk*, associated with the four directions of rain (Wrem and Helmke 2013: 169–177), or the burning of copal incense, which plays an important part of rain-making rituals even today, with smoke representing dark clouds laden with rain (Thompson 1970: 264; Schaafsma and Taube 2006: 234, 263). Apart from specific rain-making rituals, various ritual obligations related to agriculture have been documented in the Maya area as well (see for example, Tzul 1993; Wilk 1997; Haste and Da Ceuster 2001; Grandia 2004).

As discussed in Chapter 4, in 2011 one of the authors (Jobbová) of this chapter took part in ethnographic fieldwork in Cayo and Toledo Districts of Belize (Downey and Jobbová 2011), with the goal of gathering information from interviews concerning historical climate variability, drought and adjustments to changing weather patterns. Part of the goal was to identify specific ceremonies related to drought or other types of climate stress, and to establish whether such practices persisted in Belize into the 20th century. The results indicated different coping strategies linked to environmental disaster or stress (especially drought, but also locusts, hurricanes, floods and fire), but amongst the strategies was a surprising variety of rituals that could be used during periods of drought. It is this aspect of that work that we would now like to draw out further. Some of these ceremonies were more general-purpose agricultural rituals, involving fasting, abstinence and cleansing, followed by the ceremonial burning of copal incense in the community church, in agricultural fields or in the cave of *Tzuultaq'a* (polytheistic deities thought to inhabit caves and the earth, which are still worshiped in indigenous communities in the Toledo district). In the Cayo district, these rituals involve the mountain spirits, which are called *Mam* or *Witz-Jok* [*Huitz-Hoc*] or, most commonly in the interviews, *Nuukuchtat* (also referred to as *'dueño de la milpa', 'dueño del agua'* and *'dueño del monte'*). These rituals often include offerings of food and/or drink, and informants emphasised that, to ensure effectiveness of rituals, they typically have to be performed simultaneously by all the village elders. Other types of rituals were area-specific, such as a rain-beckoning ceremony called *Ch'a-cháak* (clearly related to *Chaahk*, an ancient Maya rain deity, a personification of thunder and associated with rain and clouds; see Stone and Zender 2011: 41; Wrem and Helmke 2013), known especially in the Yucatan, but also in parts of northern and central Belize. While there were many local differences, especially among the descriptions of general-purpose drought-related rituals across the two study regions (Cayo and Toledo), one ritual was described in nearly identical ways in both regions: If it did not rain, the village's saint was taken out from the church and 'bathed' in the spring or left out in the sun until the stone started to sweat at which point, water was poured over it. Interestingly, the eminent Mayanist, J. Eric S. Thompson, documented a similar ritual in his research in the 1930s, in the village of San José Succotz in the Cayo district and at San Antonio in the Toledo district. He describes the rain-beckoning ceremonies as follows:

> If the prayers for rain are not effective, the Mayas call the attention of the saints to the drought. Any saint from the church is taken outside and placed well in the sun, so that he or she may be convinced how parching are the hot rays of the sun. Undoubtedly in earlier times a statue of one of the rain gods was the victim of this irreverent treatment. At present no statues of the old gods survive and the Christian saints have to suffer in their place. Sometimes the saint is taken out of the church and marched around the building, while prayers are offered to Huitz-Hok and Santa U [the moon]. The previous night is passed in vigil (Thompson 1930: 53).

A quick comparative view that follows shows that the use of effigies in agricultural and/or specifically rain-making ceremonies has a long tradition and is geographically widespread. God effigies that were carried to a river and washed formed part of such rituals in ancient Egypt, Mesopotamia, Sumer, Hittite Anatolia, Classical Greece and Rome. These processions were often followed by a sacrificial offering and a communal meal (Başgöz, 1967: 305). Many aspects of these rituals have survived and are still used in rainmaking-ceremonies today, or persisted until

recently. In Turkey, for instance, a doll made by children is carried through the village, with stops at series of houses where water is poured over the head of the doll. The children are offered food that is then cooked and eaten afterwards (Başgöz, 1967: 304). Very roughly analogous ceremonies, involving a girl dressed in greenery, representing a rain goddess, going from house to house singing songs and being sprinkled by water, have also been performed in the Balkans, especially Serbia and Bulgaria until the 1960s and in some places until today (Berengarten 2006).

Especially close parallels to rainmaking rituals reported in Belize can be found in other tropical environments, such as Southeast Asia. The *Songkran* festival, from the Sanskrit word *saṃkrānti* describing astrological passage and marking the beginning of a new Solar year (Monier Williams 1899: 1127), is widely celebrated in South Asia. This New Year festival, which can be traced back to India stemming from Hindu rituals, is celebrated in several countries in Southeast Asia, such as Burma, Cambodia and Laos, although under different names. The festival takes place during the hot and dry period of the year (for example, the 13th to 15th of April in Thailand), prior to the onslaught of the monsoon, when people pray for good rainfall and an abundant harvest in the upcoming season. Rituals during the festival are performed in order to pay respect to the divinities associated with rain, and water, as the symbol of life, plays an important role in the festival because without it, rice – the most important staple crop of Southeast Asia – cannot grow. During the festival, the Buddha images, small enough to carry, are taken out of the monasteries and carried through the streets while people pour or sprinkle scented water on them, ritually bathing them (Milne 1924; Rajadhon 1956, 1958, 1961; Ashley 2005). Similar rituals, with slight variations, are performed during the *T'ngai Leang Saka* (the third day of a Cambodian New Year) and *Boun Pi Mai* (Laos New Year) (Rajadhon 1961; Chiebriekao 2008; Fig. 8.8a, b).

In Thailand and Cambodia, a royal ploughing ceremony, called *Phra Rat Cha Phithi Charot Phra Nangkhan Raek Na Khwan,* which literally means the 'royal ploughing ceremony marking the auspicious beginning of the rice growing season' (Royal Institute Dictionary 1999) is also performed. It is an ancient ritual of Hindu origin, which dates back to the Sukhothai period (AD 1238–1438) and

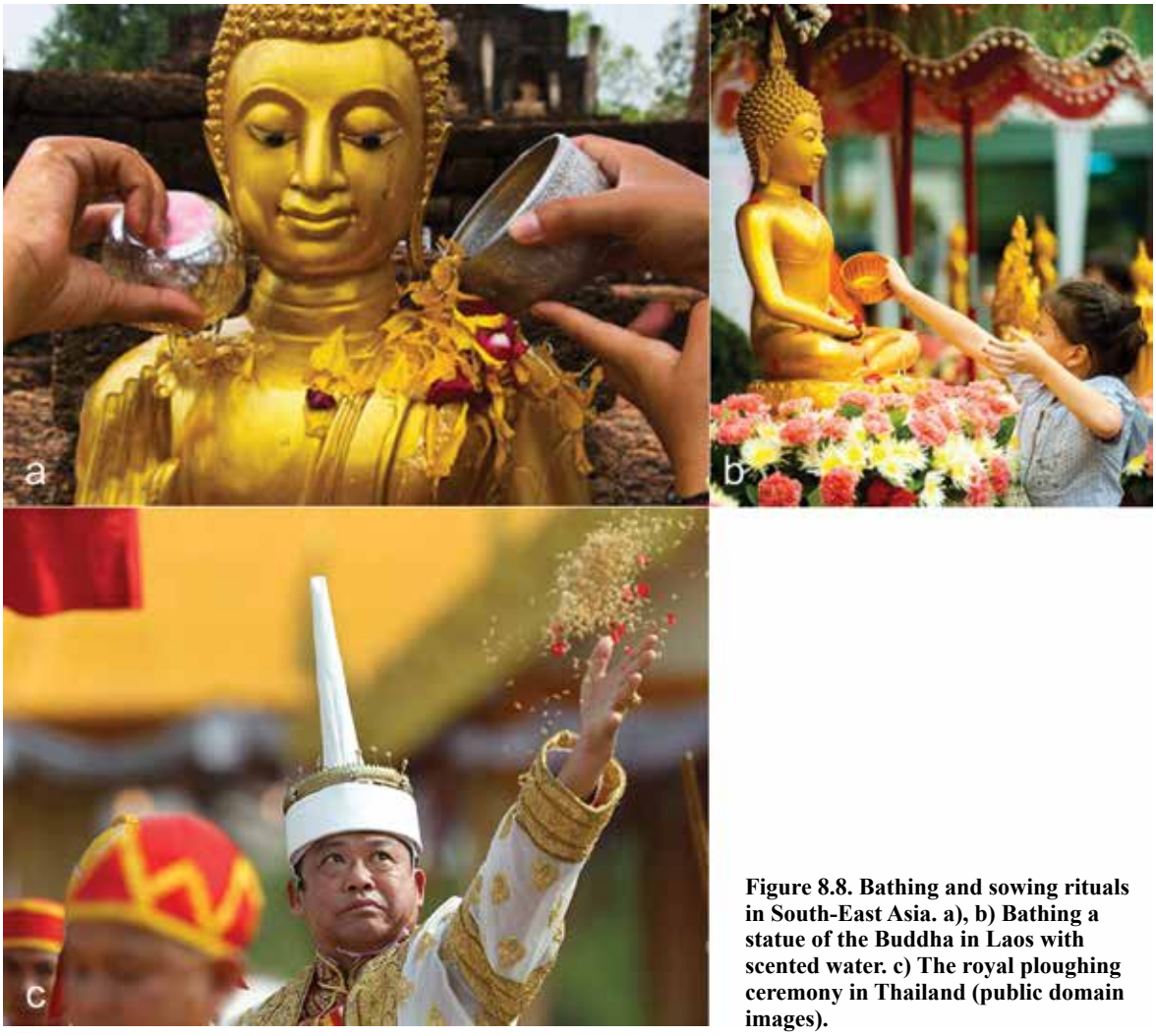


Figure 8.8. Bathing and sowing rituals in South-East Asia. a), b) Bathing a statue of the Buddha in Laos with scented water. c) The royal ploughing ceremony in Thailand (public domain images).

usually takes place in May, June or July, the exact date being set by Brahmin astrologers of the royal household. The ceremony involves the king, as the lord of the harvest, tilling the ground with the plough being pulled by sacred bulls. Various food choices, such as rice, green beans, grass, grain, sesame, soy beans, but also water and rice whisky, are offered to the bulls after the ploughing and their choice predicts which crops will be bountiful during the coming season. At the end of the ceremony, the king scatters the rice over the ploughed furrows, which people quickly gather, believing that it will ensure a good harvest (Fig. 8.8c). The ploughing ceremony plays an important political and economic role and, in addition to being a religious ritual, it is also a state event. It represents a bond between the king and the farming class, which sustains the country both economically and in terms of subsistence production (Crawfurd 1830). This ceremony has also been recorded in Burma as one of the rain invoking rites. During these rites, the king who was obliged to perform to prove his nobility and illustriousness, takes on the role of a 'peasant king', as 'one of them', and theoretically inspiring peasants to work hard for a plentiful harvest (Maung Nyunt 1997).

Returning to the Maya area, we can find similar associations between the bathing activities mentioned earlier and rain in the ethnographic evidence. For example, in Ch'orti' curing texts we find a phrase (Hull 2003: 518):

E Katata' ch'a'rte' rueda,

Ayan e Katata' war ajchia'tesna,

K'aniak'axi e jaja'r.

'Our father is lying down in a ring,

There our father is indeed being bathed,

It is going to rain.'

or:

E Katata' war a'tesna,

K'aniak'axi e jaja'r.

'Our father is being bathed,

It is going to rain'

The word *Katata*' in the phrases above can be segmented as ka-tata wherein *ka-* is the possessive pronoun 'our' and *tata* is a sound symbolic baby speech akin to *papa*. So literally it is 'our father' and it applies to the idea of bathing the heavenly bodies, especially to the 'sun' and the 'moon'.

Hull (2003: 520) further links these healing texts to the watery rings surrounding the sun and moon, representing the idea of 'bathing' of the sun and the moon (Fig. 8.9). The watery rings are an optical phenomenon, wherein the sun and the moon are surrounded by a halo caused by the refraction of light from ice crystals contained within thin cirrostratus clouds. These clouds are generally the first layer of clouds that are seen as a storm system approaches. There are many weather rhymes and proverbs about these rings; for example: 'A Moon with a circle brings water in her beak', or 'A ringed Moon means rain in a day or two', or as the Zuñi Indians say: 'When the sun is in his house it will rain soon' (Dunwoody 1883: 77, Inwards 1972: 86, 89). As in many other cultures, for Ch'orti' these rings are the predictor of impeding rain. Moreover, according to Hull (2003: 519), Ch'orti' are able to predict weather based on the duration of these rings.

8.4.2. Possible Classic Maya parallels

Ritual activity as a mechanism for dealing with environmental stress has been widely discussed in anthropological literature (see discussion in Chapter 3), and the extent of surviving Precolumbian beliefs in contemporary Maya rituals have been commented on by several archaeologists and anthropologists (see for example, Thompson 1930, Vogt 1976, 1998, Schuster 1997). The above-described rain-beckoning ceremony recorded by Thompson provides a link between contemporary rain calling rituals (discussed in more detail in Chapter 4) and those recorded by him in the 1920s. However, at least some aspects of these rituals might have a much longer tradition and could have survived from Precolumbian times. As discussed in Chapter 3, there is archaeological evidence of increased ritual activity in the caves of Western Belize, during the latter part of the late

Figure 8.9. Watery rings surrounding a) the sun and b) moon (photos: a) Kit Case licensed under CC BY-SA 2.0, B) santafeegret, licensed under CC BY 2.0.

Classic period (ca AD 680–960), coincident with climatic drying (Moyes 2006, Helmke 2009, Helmke et al. 2019). Can we, however, see some indication of similar rituals in Classic Maya hieroglyphic texts?

Among ceremonies portrayed on Classic Maya monuments, there are two particular kinds of rituals that predominate during the Terminal Classic that we examine within this case study. The first involves the 'scattering' of precious substances and the other the 'bathing' of a particular pair of deities, known as the 'Paddler Gods' (Schele and Miller 1986: 52, 183; Freidel et al. 1993: 91–94; Stone and Zender 2011: 51, 69; Stuart 2016).

'Bathing' ritual

Taking a closer look at these rituals, starting with the stelae from the sites of Ixlu and Jimbal, we can see Paddler gods depicted in the upper corners of the scene, floating within dotted-scroll motifs that represent clouds, above the king, who performs a 'scattering' ceremony (Schele and Miller 1986: 52, 183; Stuart et al. 1999: 169–70) (Fig. 8.10a).

The Paddlers are an important pair of Maya deities, however, their names remain to be deciphered. One of the pair is nicknamed the Old Jaguar paddler, and can be recognised by his jaguar spots and the ear of a feline. The other is called the Stingray Paddler after a prominent stingray spine or a bone piercing his septum (Fig. 8.10d). In the glyphic form, their names are often depicted by signs that look like small, stylised paddles, where one Paddler is represented by a sign for *k'in* ('sun, day') and the other by *ak'bal* ('night') (Stuart 1984: 13–15) (Fig. 8.10c). One of the common representations of the Paddler Gods shows them paddling a long dugout canoe, as in the scene incised on a human bone found in Burial 116 at Tikal, Guatemala, where the Paddlers are ferrying the deceased Maize God through the waters of the underworld to a place of his eventual resurrection (Freidel et al. 1993: 92; Stone and Zender 2011: 51) (Fig. 8.10b). Based on other inscriptions, we know that these deities are associated not only with the creation of the world (Freidel at al. 1993: 92), but also with rain. For example, Stela 1 from the site of Jimbal, specifically mentions *Chaahk*, the Maya deity of thunder and rain immediately after the names of the Paddlers (Fig. 8.11).

In the ritual commemorated on Stela 2 of Ixlu (Fig. 8.10), the Paddler Gods are shown floating within dotted-scrolls. In earlier studies, this scroll motif was seen as a representation of blood (Schele and Miller 1986: 52, 183; Stuart 1988: 184) and the Paddlers were, therefore, thought to be born from the bloodshed during the auto-sacrifice of the king (Stuart 1984: 14–15; Schele and Miller 1986: 52, 183). However, since then the glyph for *muyal* 'cloud' has been deciphered (Houston and Stuart 1990: 1), it is now clear that the dotted-scroll motif is best understood to represent clouds, both of rain and incense, the two being symbolically equivalent (Houston and Stuart 1990). More recently, it has been suggested by David Stuart and Stephen Houston that these scenes depict the Paddler Gods undergoing a 'bathing' ritual, as a kind of rite of purification (Stuart et al. 1999: 169–170), to which Stephen Houston has added that these scenes and accompanying statements may relate to 'rainmaking rituals' (Stuart at al. 1999: 171).

Furthermore, looking at the texts accompanying these scenes, David Stuart and Stephen Houston have noted the close association between the Paddler Gods and a particular verbal statement (Fig. 8.12) that is usually written as **ya-AT-ji** or **ya-ti-ji** – where the latter phonetic spelling has assisted with the decipherment of the more common logographic spelling (Stuart et al. 1999: 169; David Stuart pers. comm. 2000). The root of this verbal expression is *at* 'to bathe', however, based on the interpretation of this expression either as an intransitive nominalised construction with a possessive prefix, or as a transitive construction, involving a perfective suffix –V*j*, this expression could be translated in former case as 'it is the bathing of the Paddler Gods', where the Paddler Gods are the patients receiving the 'bathing' (Stuart et al. 1999: 169; Prager 2013: 261), or in latter case as 'the Paddler Gods bathe(d)', in which case the deities are the agents performing the action (MacLeod 2004: 294; Alfonso Lacadena pers. comm. 2013).

'Scattering' ritual

The 'scattering' ritual was relatively well known throughout Mesoamerica, with a long tradition and wide geographical distribution. Both iconographic and glyphic forms of this ritual are common. Its earliest iconographic form appears probably as early as 900 BC on the Humboldt Celt, interpreted by Justeson (1986: 443) as a possible ceremonial casting of maize kernels. The scene usually shows a king with outstretched arm and open hand throwing or scattering small round objects (Fig. 8.13a). The written form is in fact very similar, wherein the glyph depicts an open hand with small dots or circles falling from it (Fig. 8.13b-c). One of the early glyphic forms might be inscribed in Isthmian writing on La Mojarra Stela 1 in Veracruz dating to the 2nd century AD (Justeson and Kaufman 1993: Fig. 6). Helmke and Nielsen (2014: 89–91, 93, Figs 9a–b, 11) suggest that Early Classic examples were also commonplace at Teotihuacan. In Maya writing, the glyph is read *chok* and has been translated as 'to scatter', 'to sprinkle' (Schele and Grube 1995: 40; Stuart 1984: 9). While this reading has been accepted and is now clear, there has been an ongoing debate about what the bead-like objects falling from the hand represent. Suggestions include droplets of water (Kelley 1962: 40; Dütting 1974: 50; Thompson 1962: 300f), grain (Proskouriakoff 1993; Thompson 1962: 300f; Justeson 1986: 443), blood (Stuart 1984: 9; Stuart 1988: 187; 188; Schele and Miller 1986: 181–182), incense pellets (Love 1987: 11–14) or a combination of these (see Landa in Tozzer 1941: 140–144).

Taking these suggestions into account but also comparing the 'bathing' and 'scattering' with the observations made above from ethnographic and ethnohistorical studies (as

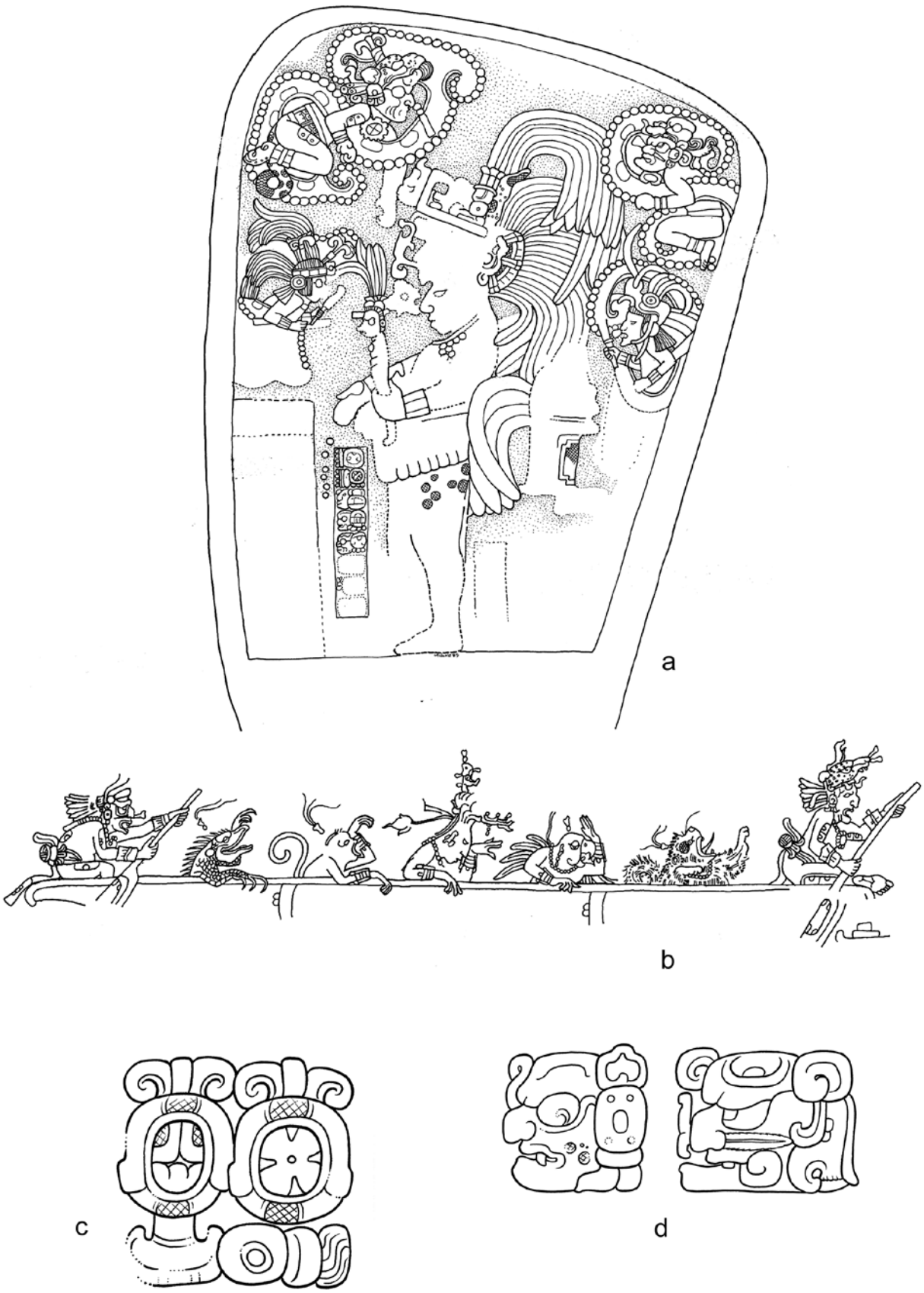


Figure 8.10. a) Stela 2 at the site of Ixlu dated to AD 879 in the Terminal Classic. Note the Paddler deities riding the dotted cloud scrolls above the king who performs a scattering ceremony (Drawing by Linda Schele © David Schele, Photo courtesy Ancient Americas at LACMA (ancientamericas.org), SD -2054). The Paddler deities in Maya imagery and writing. b) The Paddler deities ferrying the deceased Maize God to the watery underworld (Linda Schele © David Schele, Photo courtesy Ancient Americas at LACMA (ancientamericas.org), SD-2014). c) The name glyphs of the Paddler deities in the shape of diminutive and stylised paddles (Stucco text at Tonina). d) The name glyphs of the Paddlers representing their profiles and characteristic traits (Stela C at Quirigua) (drawings by Christophe Helmke).

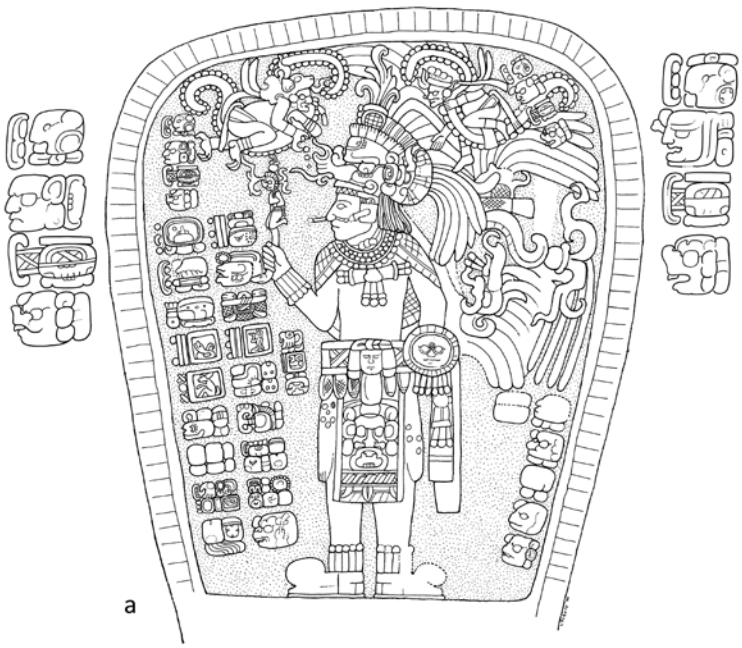


Figure 8.11. Jimbal Stela 1, dated to AD 879 in the Terminal Classic. Note the Paddler deities floating above the king who brandishes his sceptre. The glyphic captions name each of the Paddler deities as a *Chaahk* entity (final glyph), personifying rain and thunder (Drawing by Linda Schele © David Schele, Photo courtesy Ancient Americas at LACMA (ancientamericas.org), SD-2029; glyphic captions drawn by Christophe Helmke, based in part on photographs of the Atlas Epigráfico de Peten, courtesy of Dirección de Patrimonio Cultural y Natural de Ministerio de Cultura y Deportes, Guatemala).

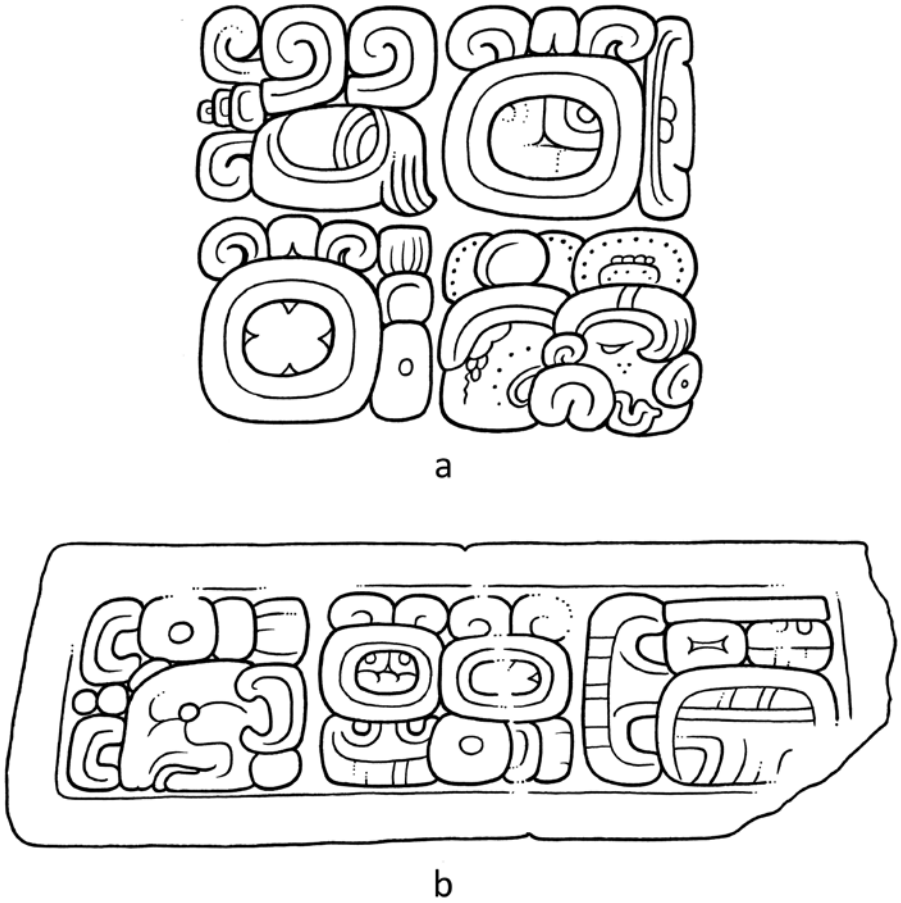


Figure 8.12. Examples of the yatij 'bathing' expression connected to the Paddler deities in Classic Maya writing. a) Side of Stela 22 at Naranjo (ya-AT-ji) where the Paddler deities are qualified as *junpik k'uh* 'eight thousand gods'. b) Detail of Monument 42 at Tonina (ya-ti-ji) that provides the Paddlers with the title *Nah Ho' Chan Ajaw* or 'kings of the First Five Skies' (drawings by Christophe Helmke, after drawings by Ian Graham and Peter Mathews).

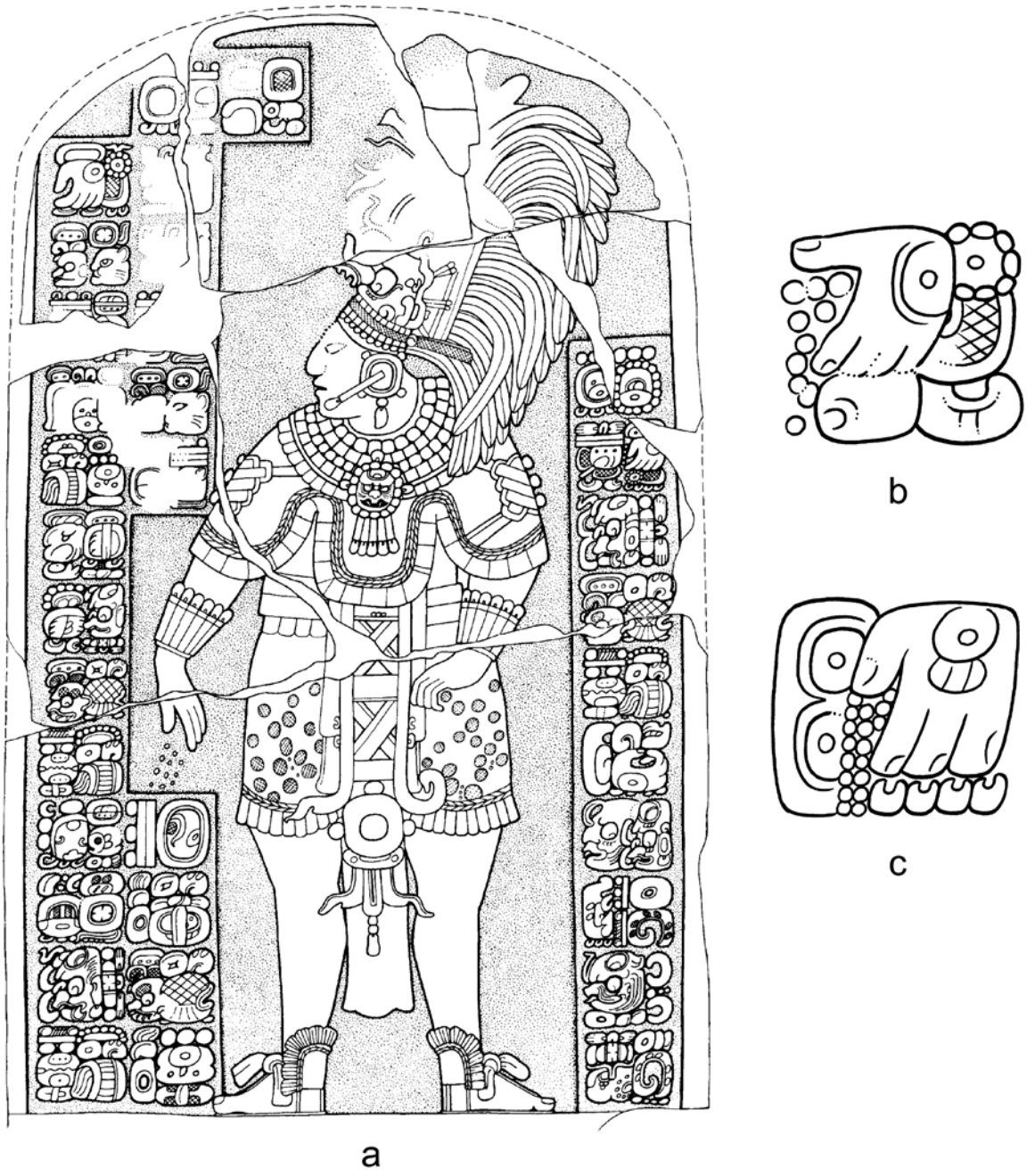


Figure 8.13. The *choko'w ch'aaj* 'the scattering of drops' ritual in Classic Maya imagery and writing. a) Stela 1 at Aguateca that shows the local king performing a scattering ritual in AD 741 (drawing by Ian Graham, after Graham 1968: Fig. 3, Courtesy of the Middle American Research Institute, Tulane University). b) The verbal root of this ritual is represented in writing by a hand that scatters drops (written CHOK-wa-ch'a) on Arroyo de Piedra Stela 2. c) The same expression (written u-CHOK-ji) on Tonina Mon. 104 (glyph drawings by Christophe Helmke).

introduced in Chapter 4 and above), following hypotheses were formed:

1. Symbolising the act of sowing and the invocation of rain-bearing clouds, these rituals were closely related to the agrarian lifecycle. As such, the 'bathing' rituals may be the predecesors, or proto-forms, of some of the above described later rain-beckoning ceremonies, such as the 'bathing' of the village's saint or the rituals that are known among the Yukatek Maya as *ch'a-cháak*, mentioned in both the ethnohistoric and ethnographic sources (see Rejón García 1905; Gann 1917; Irigoyen 1976; Love 1984, 2011; Freidel et al. 1993). They serve as rain-beckoning ceremonies and at present are performed annually at the end of the dry season, immediately preceding the time of planting and sowing. Similarly, the 'scattering' rituals might be interpreted as associated with agricultural ceremonies, emulating the cycles of planting and sowing of grains on the open field (Jobbová et al. 2018).
2. These rituals may conceivably have originated not just in response to general fears about water scarcity, but

also as a result of particular episodes of drought and, without pre-supposing this conclusion, it should be considered whether they might not, therefore, provide historical markers of time periods with diminished precipitation (Jobbová et al. 2018).

8.4.3 Analytical approach and data

To test the above hypotheses, we reviewed the entire corpus of hieroglyphic texts and recorded all known occurrences of these two particular types of rituals: 'bathing' or *yatij* in Classic Maya and 'scattering' or *choko'w ch'aaj*. There are several ways in which these two expressions can be recorded in the glyphic texts, therefore, in the remainder of this section we refer to each of them by the verbal root of the action: *at* and *chok* respectively. An added advantage of focusing on these two specific rituals is the predominance of *at* in the Terminal Classic, whereas *chok* appears throughout the Classic period but with a high relative incidence in the Terminal Classic. Given this difference, instead of focusing on one ritual, we were able to compare the spatial and temporal incidence of two distinct, albeit symbolically related rituals, seemingly both associated with agrarian practices (Jobbová et al. 2018). Using the glyphic references we created a working database consisting of information about the site from which the *at* and *chok* statement is found, the date of the statement and the latest date of the text (this helps to assess if the event recorded is contemporary with the written source, or whether the historical iterance is highly retrospective). This database was then used to analyse the temporal and spatial distribution of *at* and *chok* statements.

Altogether, there were 23 *at* ('bathing') statements recognised from inscribed monuments at seven different sites: Copan, Tonina, Piedras Negras, Naranjo, Tikal, Ixlu, and Guaquitepec, across southern Mexico, Guatemala and western Honduras. Of these, 19 can be securely dated (Table 8.1). Four further monuments were included later on for temporal pattern analyses (two from Ixlu, one from Jimbal and one from Tikal, all dating to Terminal Classic period). Although these monuments are missing an explicitly written *at* statement, their scenes are clearly depicting the 'bathing' ritual iconographically (for example, Ixlu, Stela 2; Jimbal, Stela 1). Inclusion of these four monuments is further justified by the nature of Terminal Classic texts, which are usually shorter and more formulaic than Classic ones, and therefore it is very likely that the 'bathing' ritual during this period might have been, in some cases, expressed only iconographically. Such a hypothesis is supported by the same pattern existing for the 'scattering' ritual, which in several cases is depicted only iconographically on Terminal Classic monuments as well. For *chok* rituals, there are as many as 124 statements from 38 different sites across southern Mexico, Guatemala, Belize and western Honduras. Of those 112 can be dated (Table 8.2). The spatial distribution of sites with *at* and *chok* rituals is presented in Fig. 8.14. Tables 8.1 and 8.2 are in the appendix at the end of this chapter.

Below, we first explored the monthly distribution of *at* and *chok* statements, in order to see if there was a preference

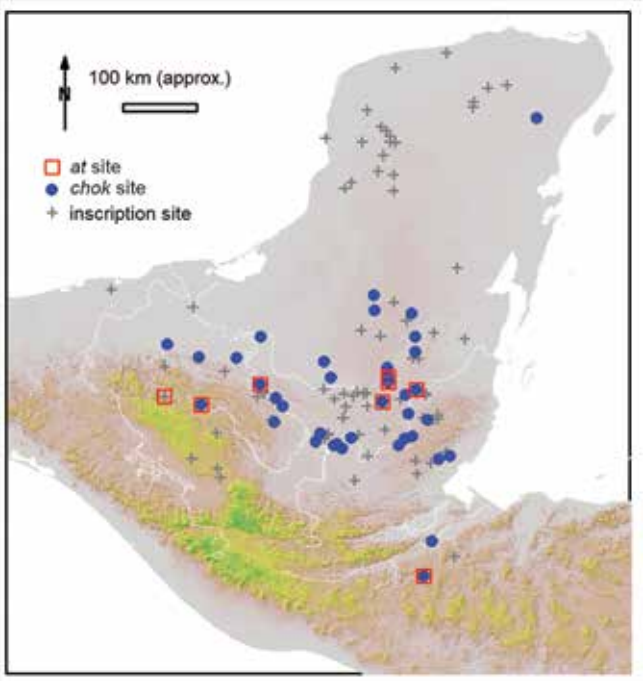


Figure 8.14. Spatial distribution of sites with *at* and *chok* rituals against all sites with glyphic texts.

for performing these rituals during certain seasons (especially given that the Maya solar calendar did not account for annual drift and, as such, the emic temporal intervals are not inherently locked to a given seasonality). If the sample size were bigger, we would have explored the seasonality of only those statements with non-period ending dates, which are more likely to represent explicitly special events such as droughts. However, because of the relatively small number of texts with the *at* and *chok* statements and the dating of the majority of them to the Terminal Classic, where texts were preferentially raised on period ending dates, this is not feasible. To compensate for this uncertainty, seasonality of *at* and *chok* statements were compared with the seasonal distribution of a much larger set of dated Maya texts, regardless of their topic (using the database compiled by Stanley Guenter 2014, which contains the vast majority of Late Classic and Terminal Classic texts). In addition, seasonality of 'bathing' and 'scattering' rituals was also compared with seasonality of other types of events mentioned in texts, such as statements about warfare (using the Maya Hieroglyphic Database, MHD, compiled by Macri and Looper 1991–2012 in Kennett et al. 2012), or royal accessions (compiled by Simon Martin, pers. comm. 2015). To further elucidate the timing of *at* and *chok* occurrences, they were compared to the seasonal distribution of total rainfall in the Maya area. We looked at the relationship between the total amount of rainfall and the number of *at* and *chok* statements at individual sites, and also between the seasonal variability of rainfall and the incidence of *at* and *chok* statements, via a regression model.

Next, we compared the longer-term temporal distribution of *at* and *chok* statements throughout the Classic period with palaeoclimatological evidence to explore whether any relationship between the occurrence of these statements and drier periods can be substantiated. Again, for observed co-

occurrences between the periods during which the statements appear in the glyphic corpus and the periods with diminished precipitation, it was necessary to consider whether these correspondences were incidental or significant. Therefore, the temporal distribution of *at* and *chok* statements was compared against the temporal distribution of all known dated Maya texts (using a database compiled by Christian Prager 2008), statistically testing these datasets using a two-sample Kolmogorov-Smirnov test (KS test). The temporal distribution of *at* and *chok* statements was examined both throughout the time of their existence (Early Classic to Post-classic) to look at their diachronic change and also separately for Early/Late Classic and Terminal Classic to explore the ways in which their occurrences differ between these two periods. Lastly, we explored some of the possible reasons why these rituals appear at some sites but not others, looking to further elucidate patterns and motivations behind the celebration of these rituals.

8.4.4. The seasonality of at and chok statements

Given that *at* and *chok* rituals appear to be related to agricultural practices, we initially explored the frequency with which *at* and *chok* statements occur in individual months, in order to see if there was a seasonal preference for the performance of these rituals (Fig. 8.15). Direct comparison with modern monthly rainfall totals does not show a significant association, however, the relationship between seasonal variability and occurrence of *at* statements (p=0.107) deserves closer examination. There is a high frequency of *at* statements in June and also in October-November that is significantly higher in comparison to other months (X^2, p=0.016). *Chok* occurrences also show higher than expected frequencies in June and October (X^2, p=0.041), although it is clear that the seasonality of *chok* statements is less pronounced than that of *at* (albeit due in part to differing sample sizes).

Interestingly, these occurrences correspond approximately with present-day planting seasons in the Maya area. The first and primary planting occurs in May, at the end of the dry and beginning of the rainy season. In many areas, especially in the humid central lowlands (for example, Peten, Belize, Chiapas and Tabasco), there is a second planting as well, which usually takes place in October or November and often involves fast ripening varieties of maize (Brewbaker 1979: 107; Nations and Nigh 1980: 10–13; Downey and Jobbová 2011: 179). The planting seasons naturally reflect the bimodal distribution of rainfall in this region, with the wet season

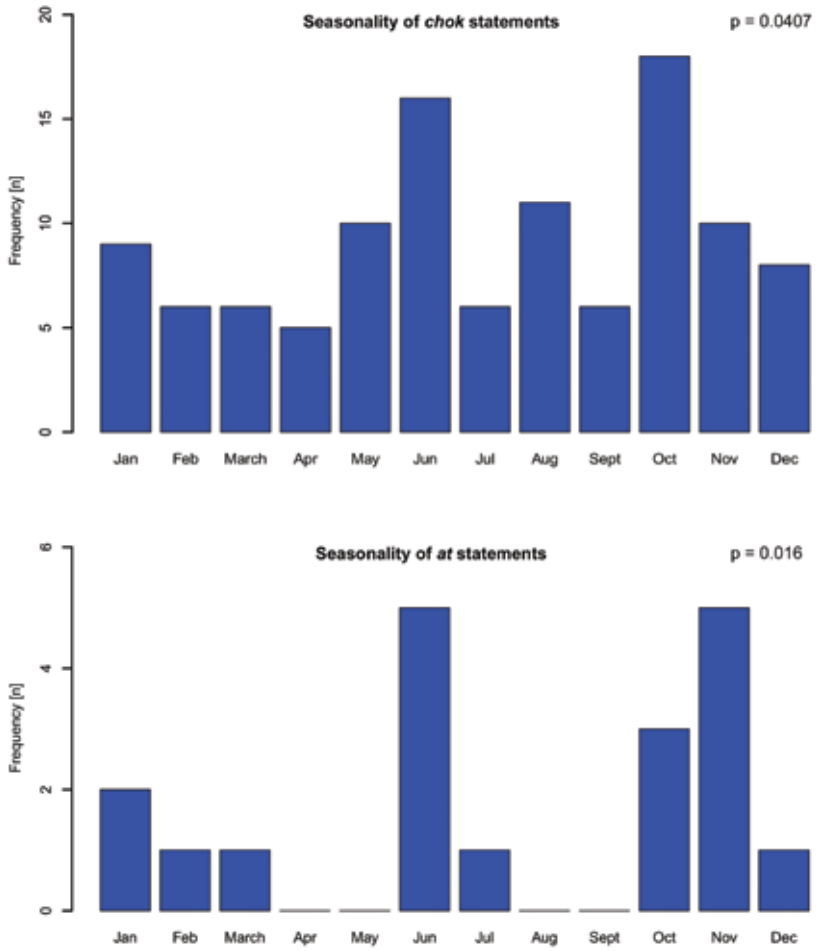


Figure 8.15. The monthly distribution of occurrence of *chok* and *at* statements, to detect patterns of seasonality.

occurring from May until November/December (with a short dry spell in August, known as the 'meagre season' in Belize or *'canícula'* elsewhere in the Maya area) and the true dry season from February to April (Hastenrath 1967; Magaña et al. 1999). The relationship between the *at* and *chok* occurrences and their correlation to planting seasons can, therefore, be further clarified by exploring the modern seasonal rainfall patterns in the Maya area.

Figure 8.16 shows rainfall during individual months at different Maya areas (with occurring *at* and *chok* statements), and Figure 8.17 shows the comparison between the mean value of rainfall in individual months and the frequency of *chok* and *at* statements. Keeping in mind that these are modern data (circa 1950–2000; www.worldclim.org), they can only be used as a proxy for the distribution of rainfall, to exemplify the wet and dry periods throughout the year. Looking at these charts we see that the wettest periods are between May–June and September–October, although in their particulars these depend on the area, roughly corresponding to the high occurrence of *chok*, but especially *at* statements, and also corresponding with planting seasons. Assuming that the seasonality of rainfall has not changed dramatically since the Classic Maya period (circa AD 250–800), these would be the months normally bringing the highest precipitation in the Maya area. As such, it can be assumed that local populations would rely on these months to bring the rain, especially in May before the main planting season. This is substantiated by modern practices among traditional Maya communities, where they often plant a week or two before they expect the rains to start. From these observations, it is reasonable to suggest that the high number of occurrences of *at* statements in June reflects situations where the planting had occurred, but the expected rains had failed to arrive, and as a result rituals petitioning rain were performed. In fact, this behaviour was observed in Crique Sarco village in southern Belize in 2011 during the aforementioned ethnographic fieldwork (Downey

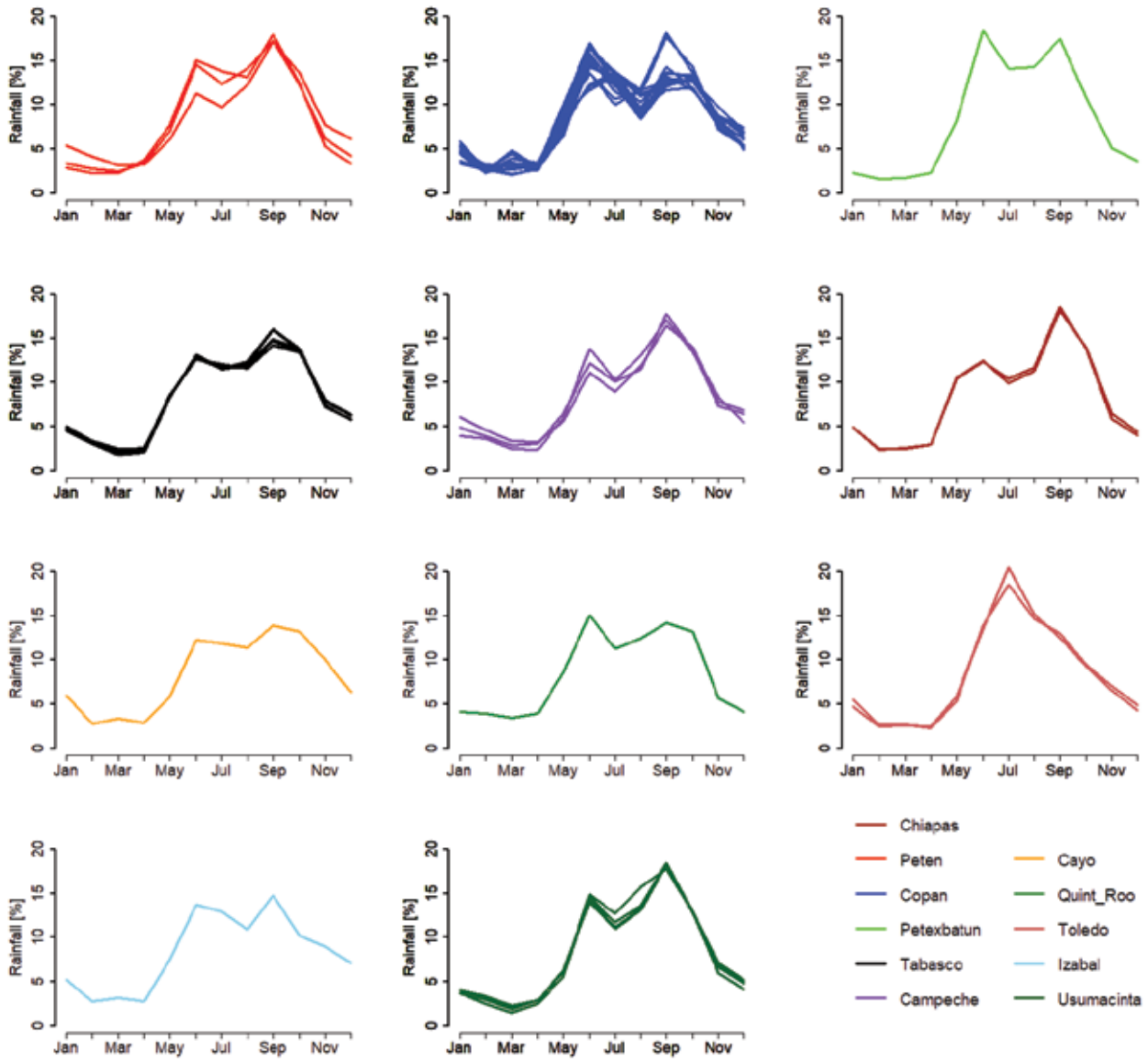


Figure 8.16. Percentage of rainfall during individual months at Maya regions with *at* and *chok* rituals.

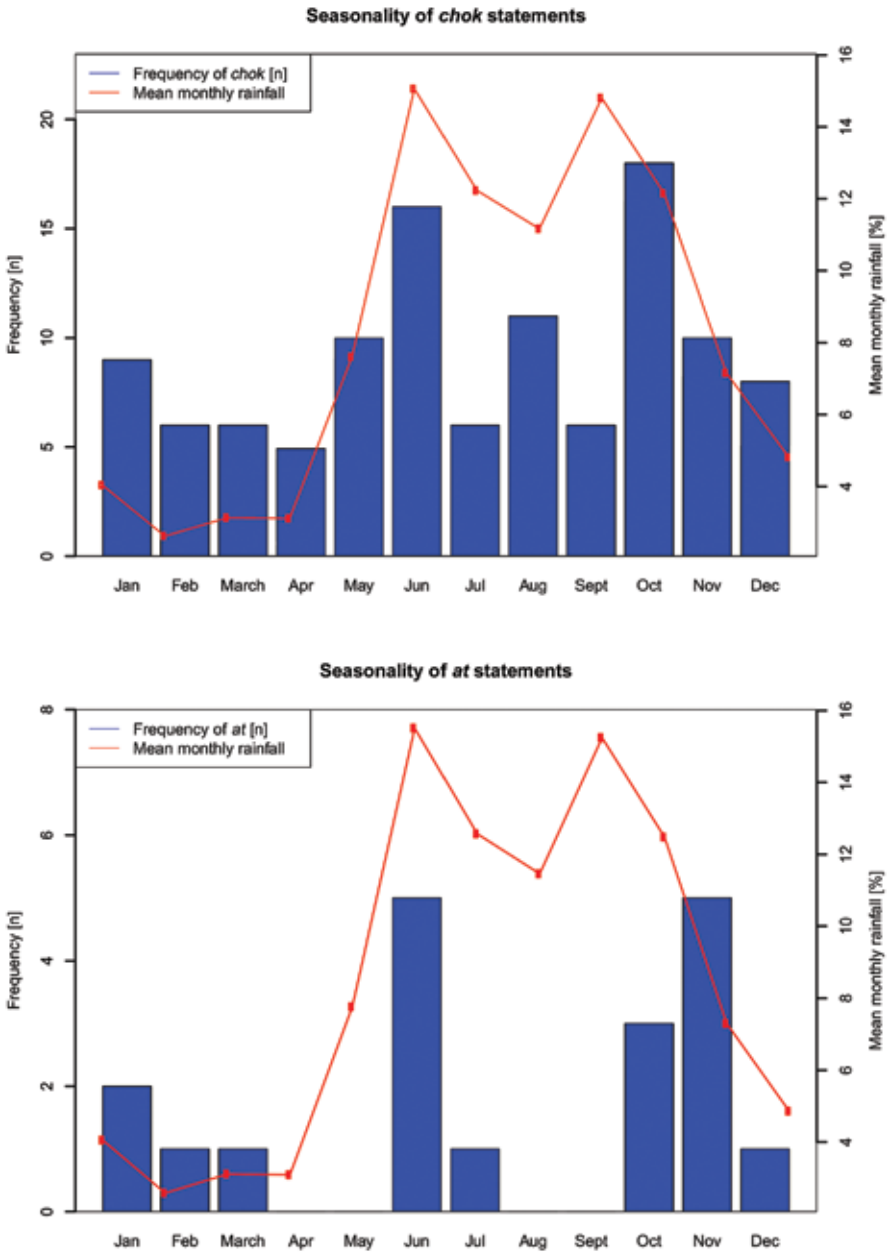


Figure 8.17. Comparison between the mean monthly rainfall and the frequency of *chok* and *at* statements.

and Jobbová 2011). We were there at the end of May and beginning of June. The locals had already planted and the expected rains were late, so people were concerned and said that they would wait another week or two, but if the rains still did not come, they would have to perform rainmaking ceremonies.

Another example is a festival performed by contemporary Yucatec Maya, known as *Pa'puul*, or 'breaking pots', which serves as a petition for rain in Yucatan, Mexico and is performed on the 24th of June. The festival involves reptiles associated with water and the breaking of pots. The sound produced is thought to evoke the clap of thunder and rain (Smithsonian National Museum of the American Indian 2017). Many aspects of the *Pa'puul* festival most likely originate in ancient Maya tradition, not least since particular period ending ceremonies involved the discard of pottery and kitchen utensils at the turn of the calendrical phase (Tozzer 1941: 151–152; see also Pendergast 1971: 9).

While it is clear that the occurrence of *at* statements is highly seasonal, supporting the hypothesis that these are somehow involved in or represent an early form of rain-beckoning rituals, this is less the case with *chok* rituals. This might be caused by their wider geographical and temporal distribution, but more likely it is because *chok* or 'scattering' rituals were (at least initially) more general purpose ceremonies associated with annual sowing and fertility, and less directly related to rainfall rituals, so they might have been performed at a variety of times of year, on a slightly more *ad hoc* basis.

To further assess the significance of seasonality of *at* and *chok* statements, or more precisely their correspondence with the raining seasons, we wanted to check if other events mentioned in Maya texts, such as accession to kingship or warfare, or indeed all dated Maya texts in general would also be seasonal, and if so, in what way? We would expect Maya texts in general and texts referring to accession events to be less season-dependent and, therefore, suitable for independent comparison with *at* and *chok* events. Figure 8.18d shows that texts in general exhibit a more random distribution of texts across the year, not consistent with either dry or rainy seasons. Texts talking about warfare events show a slightly greater but statistically insignificant prevalence during the dry season (Fig. 8.18b), which is also the case for accession events (Martin 2014: chart 3). Simon Martin has, in fact, suggested that the Classic Maya planned public ceremonies at times when it would be easiest to travel and when it was least likely that the ceremony would be spoiled by rain (Martin 2014: 100). Similarly, Martin (2014: 170–174) argues that warfare would be more likely to take place during the dry season than the wet season when people are occupied by planting, echoing an earlier similar observation by Linda Schele (Schele and Freidel 1990: 62). In summary, *at* and *chok* statements exhibit higher seasonality than other kinds of texts, and stronger congruence with the start of the rains and planting seasons.

8.4.5. Palaeoclimate and at and chok statements

In order to explore the second hypothesis, that these rituals may have originated in response to particular episodes of drought and as such could serve as markers of diminished precipitation, the distribution of the *at* and *chok* statements through time was also compared with palaeoclimatic evidence for periods of greater or lesser rainfall (Fig. 8.19). Due to the considerable geographical variability in climatological records, the central Peten, which roughly provides a geographic median of the Maya world, was chosen as a case study area. This region provides palaeoclimatic data from the Macal Chasm speleothem (Webster 2000; Webster et al. 2007, Akers et al. 2016), the sites located in the area mention both *at* and *chok* rituals and, in fact, produced the majority of *at* and *chok* statements during the Terminal Classic period (Fig. 8.20).

Looking at Fig. 8.20, it is tempting to see the correspondence between the periods during which *at* and *chok* statements appear in glyphic corpus, and the periods with diminished precipitation, as evidence that the increase of these rituals was indeed related to particular dry periods (at least in this specific area). To find out if this co-occurrence is only incidental or significant, the temporal distribution of *at* and *chok* dates for all the sites where these statements appear was compared against the

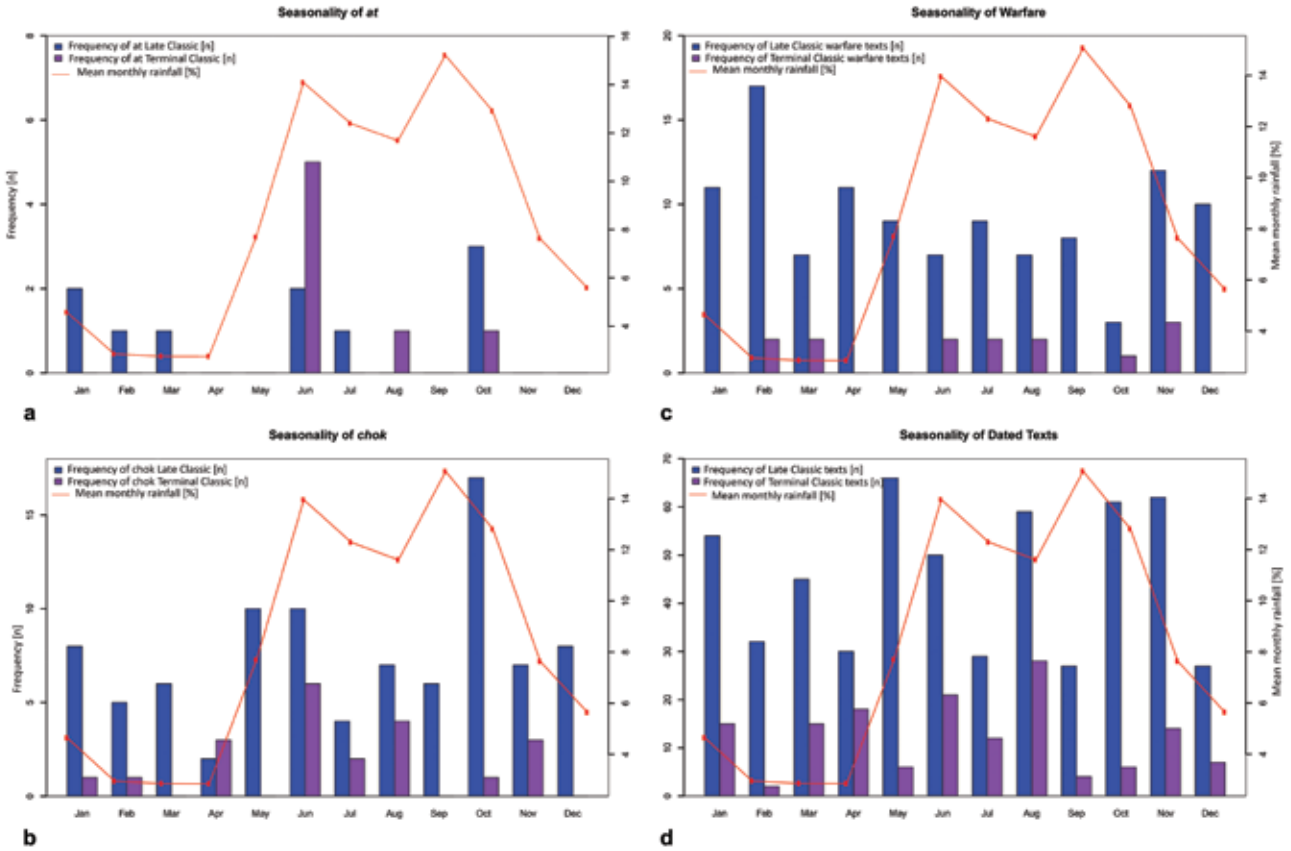


Figure 8.18. Seasonality of a) *at* and b) *chok* statements in comparison to seasonality of c) warfare statements and d) the incidence of known dated texts, contrasting the Late Classic incidences against those of the Terminal Classic.

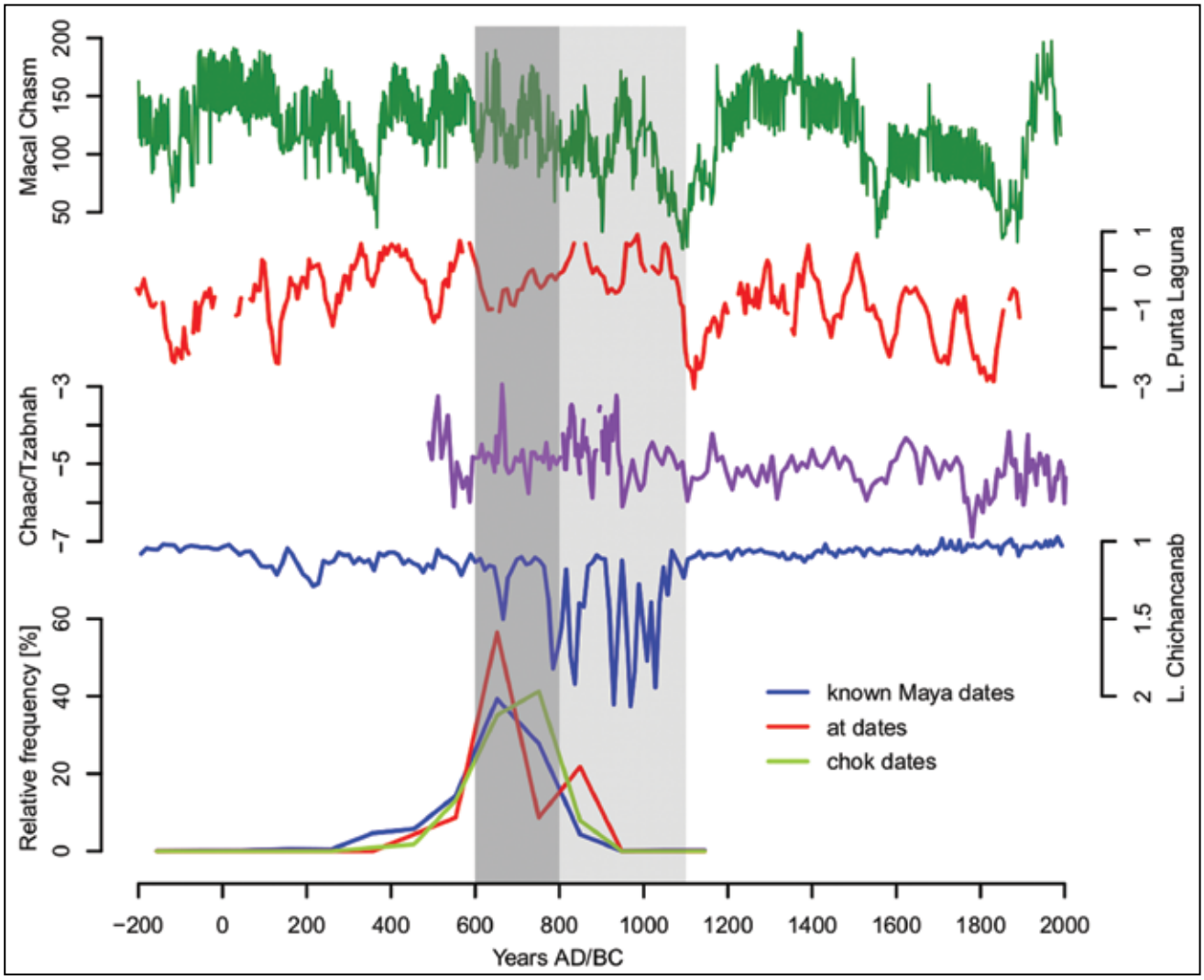


Figure 8.19. Comparison between palaeoclimatic records (Macal Chasm – Akers et al. 2016; Lake Punta Laguna – Curtis et al. 1996; Chaak/Tzabnah - Medina-Elizalde et al. 2010; Lake Chichancanab - Hodell et al. 2005) and incidences of *at* and *chok* statements. The dark gray band indicates the Late Classic and wetter period and the lighter grey band indicates Terminal Classic period, with diminished precipitation indicated by most of the palaeoclimatic records.

temporal distribution of all known Maya dates from the glyphic corpus (Fig. 8.21).

In the comparison, the marked increase in the number of the *at* statements in the period AD 652–751 closely follows an overall increase of the incidence of hieroglyphic texts in general. This visual correspondence was confirmed by a Kolmogorov–Smirnov statistical test, which suggested that there was no meaningful difference between the two. Hence *at* rituals may merely have been common practices, the incidence of which in the surviving record is conditioned by sample size, rather than being something that is genuinely increased (in absolute terms) during a period of heightened water stress. There is, however, a small second peak, which, although not statistically significant, shows another increase in *at* statements between AD 850 and 900, by which time the number of hieroglyphic texts in general has decreased considerably. This peak is worth cautious attention, especially considering the relative paucity of texts and the disproportionate emphasis on this otherwise rare ritual.

Turning to *chok* statements, the peak in their occurrence appears slightly later than the overall increase in hieroglyphic texts. This corresponds with the results of K-S test (p=0.05), suggesting that the increase of the *chok* statements in the period between AD 750 and 950 is significant. Given the less pronounced seasonality and relatedness of *chok* rituals to rainfall, it is more difficult to link this peak to a period of diminished precipitation, although many palaeoclimatic records show that there were droughts occurring in various parts of the Maya area during this period (see Table 8.3).

Looking at the pattern again more closely and examining the seasonality of the *chok* statements separately for the Early/Late Classic (AD 250–800) and the Terminal Classic period (AD 800–950), the situation is slightly different

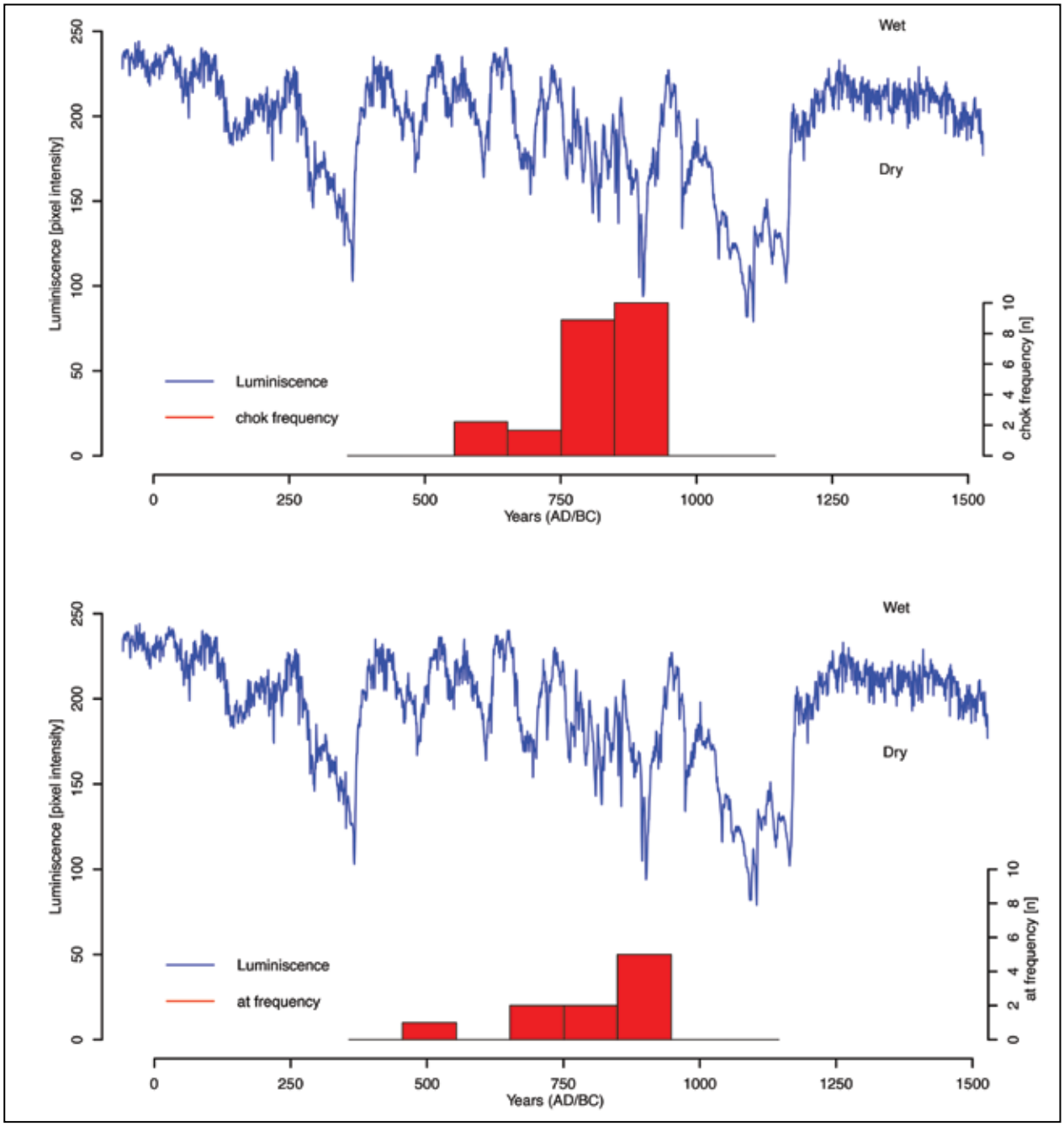


Figure 8.20. Comparison between the Macal Chasm speleothem data (Akers et al. 2016) and temporal distribution of *chok* and *at* statements (monuments with iconographic scenes are included).

and might explain the above-described increase in *chok* statements. During the Early/Late Classic period, it seems that *chok* incidence quite closely follows the incidence of accession statements and texts in general (Fig. 8.22a). This suggests that *chok* rituals may have originally been a general-purpose ritual, perhaps performed as part of the period ending rituals and, at times, as part of accession ceremonies, presenting the king as the one who ensures agricultural fertility. During the Terminal Classic period, however, the incidence of *chok* rituals is more seasonal and closer to that of the *at* statements. It is, therefore, possible that the nature and/or perception of the *chok* or 'scattering' rituals changed during the Terminal Classic period from a presumed general purpose ritual, less related to rainfall and performed in more variable seasons, to one more focused on agricultural security and rainmaking. This suggestion is supported by the fact that many Terminal Classic monuments seem to follow a pattern where *at* and *chok* rituals have been performed conjointly (Fig. 8.23). In fact, on Stela 1 from Jimbal we can see the Jaguar Paddler performing the scattering (Fig. 8.11).

8.4.6. Spatial patterning of at and chok statements

Returning to *at* and *chok* rituals, there is also a question as to why these rituals appear at certain sites and not others.

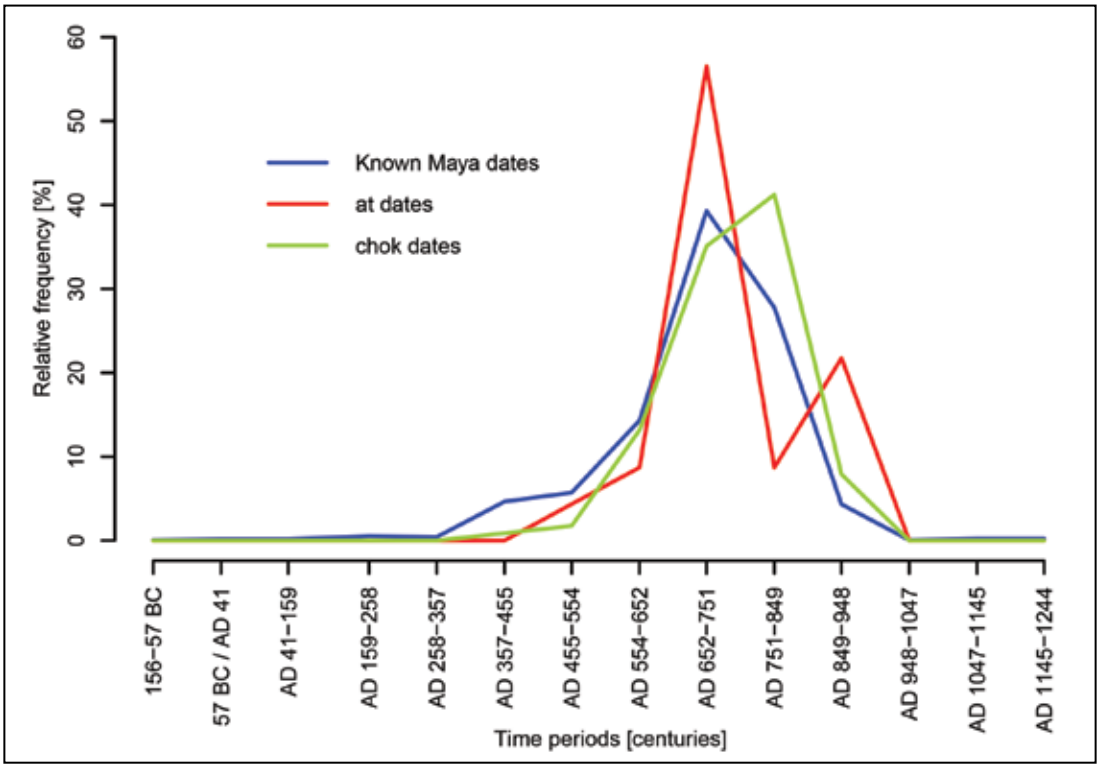


Figure 8.21. Comparison of temporal distribution of *at* and *chok* statements against distribution of all known Maya dated texts (monuments with iconographic scenes are included).

Table 8.3. Major droughts according to palaeoclimatic data from various localities in the Maya area

Locality	Dry period	Reference
Laguna Yaloch	AD 750–900	Wahl et al. 2013
Macal Chasm	AD 750–900	Akers et al. 2016
Punta Laguna	AD 760–770	Hodell et al. 2007
Lake Chichancanab	AD 770–870	Hodell et al. 2005
Lake Salpeten	AD 800–900	Rosenmeier et al. 2002
Tzabnah Cave	AD 804–938	Medina-Elizalde et al. 2010
Yok Balum Cave	AD 820–870	Kennett et al. 2012
Punta Laguna	AD 830–890	Hodell et al. 2007
Punta Laguna	AD 910–990	Curtis et al. 1996

If we test for a relationship between the number of texts per individual site and numbers of *at* and *chok* per sites, results of the chi-square test (X^2, p=5.9e-8, p=2.8e-24) indicate that certain sites produced such statements well in excess of the number of hieroglyphic texts at these sites in general. We have already looked at the modern rainfall patterns in the Maya area over the last five decades and seen that *at* is highly seasonal. The regression tests did not prove the relationship between number of *at* statements and annual rainfall, but a closer look at the rainfall data shows slightly different picture. The rainfall patterns are based on the precipitation data from weather stations all across the Maya area (Fick and Hijmans 2017). This approach, although using modern data, is much more regionally relevant (Fig. 8.24b).

Looking at the distribution of *at* statements against the precipitation values (Fig. 8.24b), all sites with 'bathing' expressions are predominantly located in areas with moderate annual rainfall, between zones with high and low annual precipitation (for example, sites like Tikal, Ixlu, Jimbal and Naranjo in Peten). Furthermore, sites with *at* rituals are located in areas without easy access to groundwater and in the case of Tikal and Jimbal also without surface water sources. It is therefore likely that variability in rainfall, perhaps fluctuating between high- and low-precipitation regimes, might have a more dramatic impact in this region than either in the rain-poor, but groundwater rich northwest Yucatan or the rain-rich southern highlands. The fact that the 'bathing' rituals are completely absent at northern lowland sites might not only be a result of northern lowland sites being preoccupied with different topics in their inscriptions, but perhaps also due to relatively regular (albeit low) rainfall, relatively easy access to groundwater sources and less dependency on maize agriculture in general.

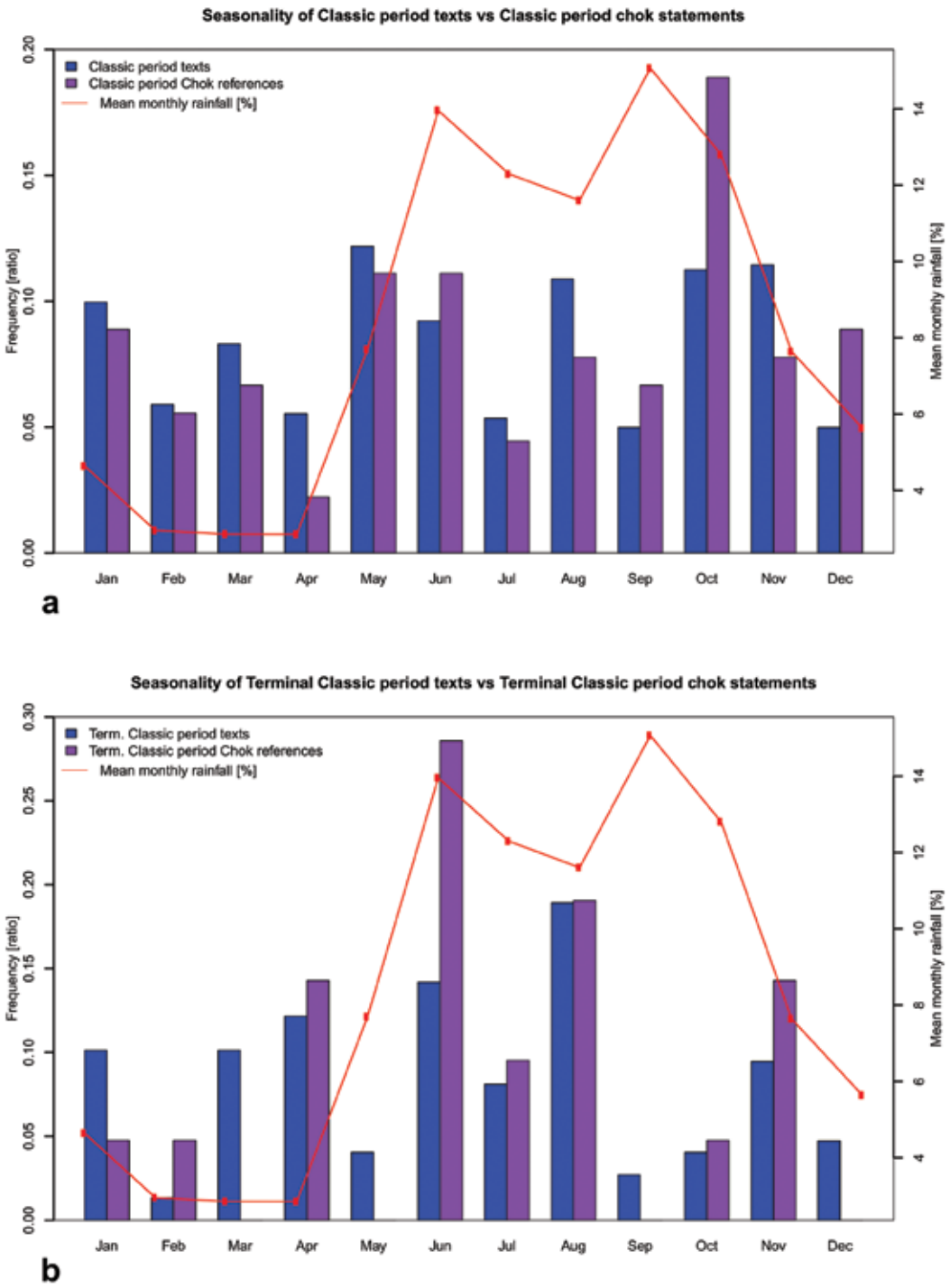


Figure 8.22. The Seasonality of *chok* statements during the Early/Late Classic and Terminal Classic period in comparison to seasonality of dated texts during the commensurate periods.

The hypothesis that 'bathing' rituals were more important in areas with higher environmental stress is supported by the spatial distribution of 'scattering' *(chok)* statements, especially during the Terminal Classic period (Fig. 8.24b). The spatial distribution of *chok* statements during the Early/Late Classic period (Fig. 8.24a) is much more regionally variable, both in terms of areas with annual rainfall and inter-annual variability of rainfall, although it is still fairly seasonal. Such a distribution of *chok* rituals suggests that they were widespread across the Maya area and their number indicates that they were much more common, at the very least as suggested by the textual evidence. Given the hypothesis that these rituals were originally general-purpose rituals and only later in the Terminal Classic their focus might have shifted to more agrarian lifecycles, it is perhaps not surprising. However, if we look at the distribution of sites with *chok* statements during the Terminal Classic, we see a very similar pattern to that described above for the *at* statements, where the sites are predominantly located in a moderately rain-fed zone between high and low annual precipitation (Fig. 8.24b).

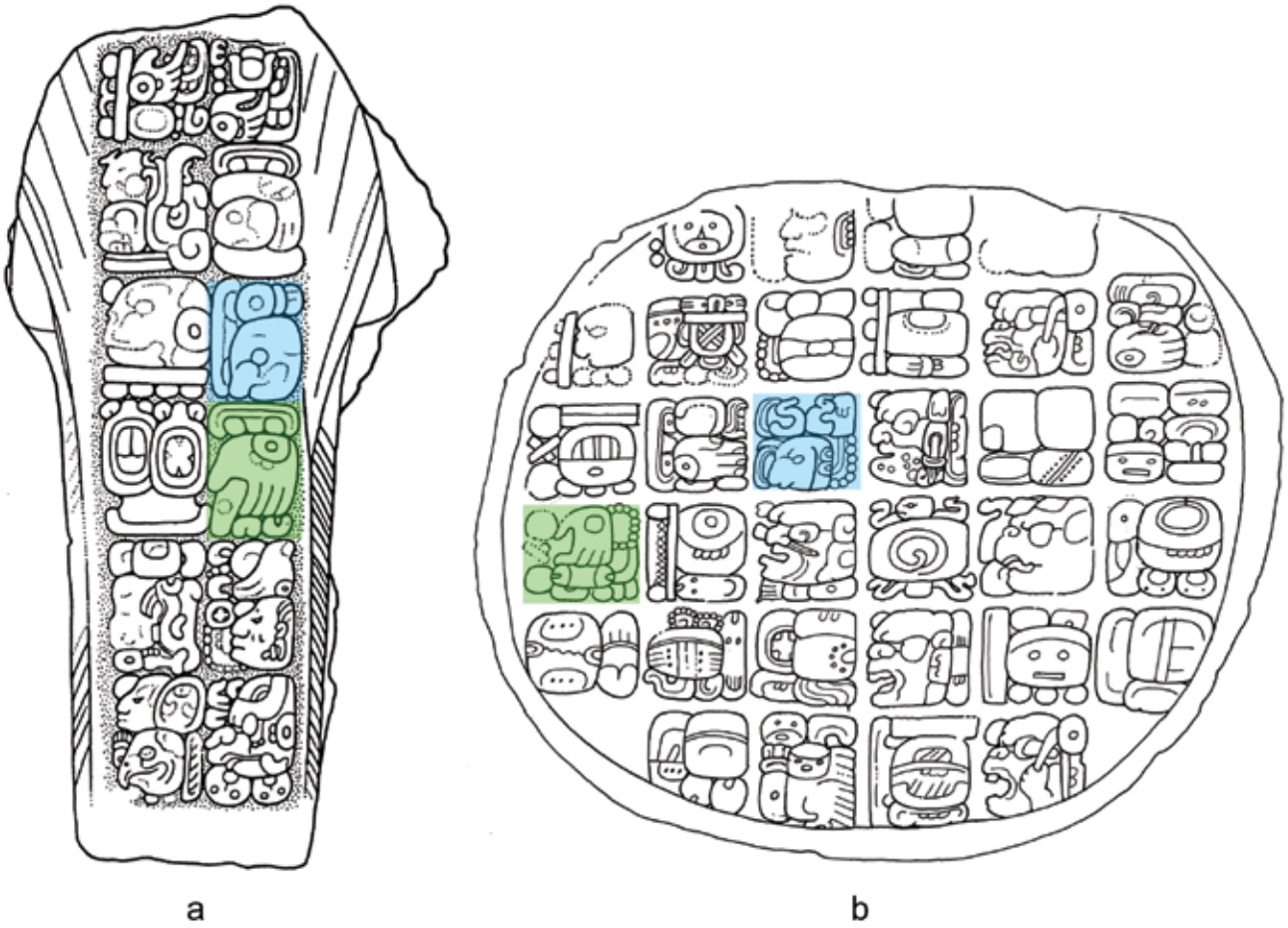


Figure 8.23. Examples of the late co-occurrence of *at* (blue) and *chok* (green) events on the same monuments. a) Tonina Monument 138 (drawing by Ian Graham © the President and Fellows of Harvard College, Peabody Museum of Archaeology and Ethnology, PM 2004.15.6.16.28). b) Ixlu Altar 1 (Drawing by Linda Schele © David Schele, Photo courtesy Ancient Americas at LACMA (ancientamericas.org), SD-2067).

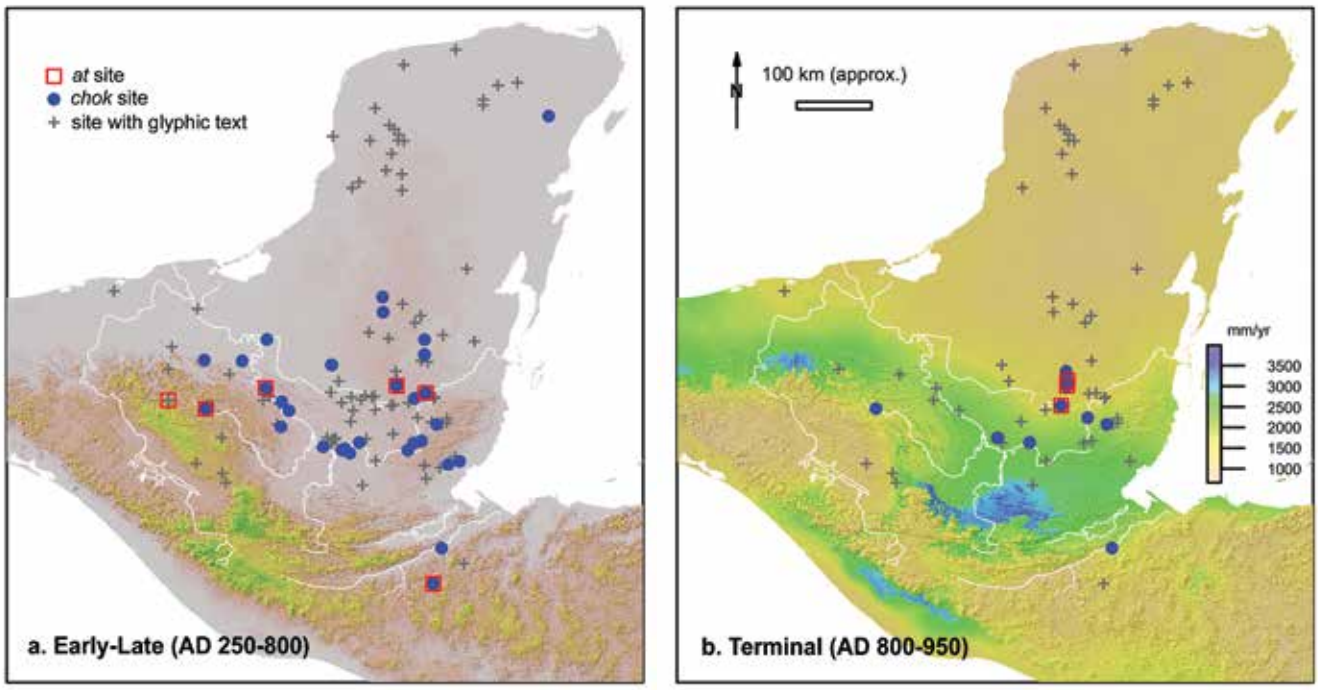


Figure 8.24. a) Distribution of *at* and *chok* statements of the Early and Late Classic against the distribution of all sites with glyphic texts. b) Distribution of Terminal Classic period *at* and *chok* statements against modern annual rainfall patterns (maps by A. Bevan and E. Jobbová).

8.4.7. Specific occasion rituals

Beyond this general geographic patterning, it is perhaps worth exploring the idea that these rituals may have been performed by certain individuals at specific occasions, and hence are idiosyncratic in certain respects. For example, looking at the *at* statements from Tonina, where nine of the 23 examples of the *at* expressions are found (unfortunately, we only have secure dates for six of them), the dates occur within a restricted period of 24 years (a span of dates that corresponds to a human lifetime). In addition, these seem to follow a certain pattern since they are performed at regular intervals, corresponding to the celebration of so-called *hotun* intervals of circa five years (AD 697, 702*, 706*, 711, 716, 721).[23] This suggests that we may be looking at the activity of a single ritual specialist, in much the same way as Comalcalco's priest *Ajpakal Tahn*, whose texts commemorate rites celebrated over a period of 12 years between AD 763 and 777 (Zender 2004: 250; Fig. 8.25).

It could also be a response to specific climactic occasions or events; for example, we know very little about the manner by which rulers legitimised themselves and how such processes might have varied from site to site, or even from ruler to ruler and this is even more true for ritual specialists. Moreover, it is clear from the hieroglyphic corpus that different sites focus on different topics in their texts, and as such it remains unclear if the predilection given to *at* rituals at Tonina is a genuine reaction to climactic events or a ritualistic narrative, or even rhetoric preference of the ritual specialists of the site.

Figure 8.25. Depiction of *Ajpakal Tahn* of Comalcalco who performed rituals at regular intervals, especially on the day 10 Sip in the Haab calendar (drawing by Christophe Helmke after Zender 2011: Figs. 71–76).

8.5. Discussion

In order to provide a historical framework for settlement and environmental changes discussed in previous chapters, and to emphasise the importance of cultural and social factors, this chapter explored cultural and political trajectories of Maya society in the two case study regions.

Despite the scarcity of glyphic texts from the Central Belizean sites (including the Peten Lakes region), the existing records reveal a few important facts. The use of emblem glyphs and royal titles by sites such as Baking Pot, Pacbitun or Xunantunich, suggest the existence of some kind of political organisation or network between these small Maya polities by the last part of the Early Classic period (circa AD 450–650, Helmke 2019; Helmke and Awe 2012). Although these polities claim autonomy, and many likely were able to manage most of their affairs independently, they are still part of wider hierarchical networks of alliance and vassalhood, marking the political environment of the Classic period.

Based on the evidence, it seems that Caracol maintained contacts with Belize Valley during the Early Classic (circa AD 250–650) and the middle of the Late Classic (circa AD 700), while Naranjo's contacts appear to be later, during the Late Classic (AD 692–820, Helmke and Awe 2012: 83). Given the scarcity and nature of the records, it is difficult to know if these interactions really were so intermittent and changing as the records suggest, or if it is more due to the missing evidence that they seem to be so. A small clue comes from the evidence from Baking Pot and Cahal Pech. As pointed out by Helmke and Awe (2012: 83), Baking Pot's interactions with Caracol and Naranjo seem to be 'sequential and temporally-discrete', most likely following the consecutive changes in political allegiances. Cahal Pech's contacts with Caracol and Naranjo seem to be contemporaneous, however. Furthermore, given the position of the sites, especially along the fertile Belize River Valley, the area and its resources would have been too valuable not to be of interest, and most likely subjected to competition for control and resources between Naranjo and Caracol throughout the Classic period. Especially as the warfare between the large centres intensified during

[23] The dates marked with asterisks conform to this five-year pattern since these events were performed on 20th of January 702 and on the 25th of December 706.

the Late Classic and demand for food increased (Ashmore 2010: 61). On the other hand, the self-sufficiency of these relatively small, within the hierarchical network, sites, such as Baking Pot, Barton Ramie and Xunantunich, might have granted them relative independence (perhaps once the majors sites such as Caracol and Naranjo lost their power and the system of allegiances and hierarchical networks had fallen apart during the Terminal Classic and Early Postclassic period), and might have played role in their comparatively late survival. We see Xunantunich claiming its emblem glyph and political independence as Naranjo's power declines (Helmke at al. 2010: 210). Xunantunich is not a unique example: as indicated by Terminal Classic texts, there seems to be a pattern during this period of smaller centres rising and claiming indepencence in the wake of collapse of many of the large powerful ones (but see Guenter 2014: 321). This shift in the power balance of the Terminal Classic political landscape may be acompanied by ideological changes. Altered composition of the stelae, from the scenes featuring the single ruler in position of power to multi-figural 'conversation' scenes, often without indication of status, might indicate the change in the perception of the concept of power and possibly the replacement of centralised royal power by power-sharing.

Epigraphic evidence from the northern lowlands, although offering fewer details about political networks and relationship between northern lowland sites, indicates a similar political organisation, consisting of city states, 'some of which were autonomous and others were not' (Graña-Behrens 2006: 120). On the other hand, the possible adoption of emblem glyphs from the southern lowlands, as suggested by their variability and inconsistent use, might indicate a different concept or perception of divine kingship (to that in the southern lowlands) and perhaps less political competition within society (Graña-Behrens 2006: 120). Although the idea of a *multepal* or a 'joint rule' political system in the Terminal Classic has now been discarded (see Boot 2007; Cobos 2000, 2007), based on archaeological evidence, for example, from the site of Mayapan (Russell 2008), it is possible that at least some northern lowland sites may have operated within some sort of power-sharing political system, rather than divine kingship, although only from the Late Postclassic onwards. The less hierarchical and competitive organisation of northern lowland sites could have then had an effect both in the case of problems resulting from social unrest and warfare and from environmental problems; for example, by having less tribute to pay and better self-sufficiency during the difficult times and might have played a role in their different cultural trajectory. As mentioned above, 'smaller' self-sufficient sites, such as Baking Pot or Barton Ramie, survive until the Late Postclassic period, although a hiatus in activity during the Early Postclassic (AD 900–1200) has been suggested based on the accelerator mass spectrometry (AMS) radiocarbon dating of human skeletons from Baking Pot (Hoggarth et al. 2014).

Iconographic and stylistic differences involving foreign elements and linguistic differences indicate not only a relationship between the southern and northern lowlands but also interactions with various areas, including Gulf Coast regions such as Veracruz and Tabasco (Andrews 1990: 261; Wyllie 2002: 305; Pallan 2012: 103). It is possible that some of these interactions might have been of a violent nature, involving the invasion of foreign people to some areas (for example, the 'Putun' from the Golf Coast at Seibal and Machaquila; Thompson 1970; Graham 1973; Guenter 2014: 197, 202–205). Most of these interactions, however, were likely through maritime trade, and specifically through the growth of mercantilism and market exchange that characterises the Postclassic economy, although it has been argued that this develops on a larger scale during the Terminal Classic period (Rathje et al. 1978: 171–173; Chase and Chase 1982; Masson 2001, 2002; Golitko and Feinman 2015). This is supported by commerce-related iconography such as gods associated with trade (see Kepecs 1999: 491).

In addition, historical and warfare narratives are replaced by and emphasis on ritual. By AD 800, the obvious war narratives disappear altogether, texts become shorter and more formulaic, temporally focused on period ending dates and mostly consisting of rituals and ceremonies, such as scattering and 'bathing', fire drilling and building dedications. After AD 800, we also see the appearance of rituals that were performed jointly by groups of rulers/nobles from several sites, curiously, sometimes former adversaries; this was described as a reconstruction of the 'old order' or people returning to what they knew worked before – performing rituals (Grube 2013; Guenter 2014). It is possible that with ideological changes taking place at this time, people returned to ritual activity that was so prominent during the Middle Preclassic period, therefore, to the period before the concept of divine kingship was widely established.

It is also possible, however, that increased ritual activity (at least as manifested in textual evidence) was prompted or exacerbated by exogenous factors, such as environmental problems (deforestation, soil erosion, drought). As discussed previously, increased ritual activity is one of the common coping strategies with environmental stress (Girard 1949, 1995; Freidel and Shaw 2000; Moyes 2006; Moyes et al. 2009). Although the connection between diminished rainfall and the demise of divine kingship (that is, blaming kings for lack of rainfall and consequent collapse) might be overemphasised in some studies (as discussed in Chapter 7), a return to or increased ritual activity during the Terminal Classic period due to dry conditions is not an unreasonable notion. In the interviews in modern Maya communities, several informants blamed the hot and dry weather on the loss of tradition and the fact that people were not performing the rain-calling rituals anymore or that they were not performed properly (not as a whole community or elders who perform them do not fast or are not 'clean' or do not know how to perform them anymore – see Chapter 4; see also Thompson 1930 for similar comments). The perceived link between climate change and loss of ritual tradition or moral decline of a society has been observed

by ethnographic studies in modern communities from different parts of the world (for example, Amazonia, Peru, Mexico, Guatemala, Uganda, India [Walker 2016, Cometti 2016, Questa 2016, Permanto 2016, McQuaid 2016, Bulgheroni 2016]). In this view, it is reasonable to assume that, in the face of diminished rainfall, kings would be expected to perform rain-beckoning/agricultural ceremonies. Even today, Yucatec Maya agricultural rituals are performed to 'maintain the proper order of things in time and space' (Hanks 1990: 361–391 cited in Dunning and Houston 2011: 63). Maya perceived time as cyclical (as opposed to linear) and they would have believed that events, such as hurricanes or droughts, would have reoccurred after a certain period of time and, therefore, could be predicted (see Edmonson 1982: xi). This is illustrated in the Maya texts known as the *Chilam Balam* books. Passages describing severe weather also indicate attempts at predicting the arrival of hurricanes. *Helel en 18 de Agosto de 1766 a[ños] lae, ca uchi chak ikal lae. U kahlayil cin dzibtic ca utzac yilic bahun hab ca bin uchic u lak lae*, 'On August 18, 1766, there thus occurred a great wind. I thus made a record of it to count and see how many years would pass before there is another' (Roys 1967: 51, 142 cited by Dunning and Houston 2011: 63). Maya codices might have had similar function, as the surviving ones seem to have served as a 'long-range (annual) weather forecasts' perhaps assisting Maya priests to 'prophesy the future' (Dunning and Houston 2011: 63). Contemporary Yucatec shamans make similar prophesies during the *xóok k'in* ('count of days') ritual, when the weather for the rest of the year is predicted on the basis of the first 20 days of the year (Love 1992). The same predictive mechanism was mentioned to us by one of the Maya farmers in the Cayo district, during our ethnographic fieldwork (see Chapter 4).

Furthermore, a link between the increased Terminal Classic ritual activity and environmental stress is supported by the results of the case study focused on two types of rituals discussed above. Close correspondence between occurrence of *at* and *chok* statements and the rainfall seasons links them closely to the agrarian lifecycle and supports the idea of these symbolising the act of sowing and the invocation of rain-bearing clouds (Jobbová et al. 2018). Furthermore, the temporal distribution of these statements and the wider climatic comparison has shown that the frequency of *at* statements matches the frequency of surviving Maya texts overall, indicating that Classic period examples of 'bathing' rituals reflect an already well-established tradition that perhaps was even performed annually (in a wider agricultural context) at the end of the dry season and before the second planting. If they did develop as a response to droughts, this most likely happened earlier in Maya history. There is, however, a small second peak in their incidence in the Terminal Classic between AD 850 and 900, which, although not significant in the case of *at* statements, corresponds with a statistically-significant increase of *chok* rituals between AD 750 and 950, therefore in the period when the number of texts in general is already declining. Such timing also corresponds with other Terminal Classic changes, such as shifts in narrative form identified in the glyphic texts, changes in stelae composition, and changes in settlement patterns. Given that many palaeoclimatic records show that there were droughts or periods with diminished precipitation occurring in the Maya area during the Terminal Classic and considering the increase in seasonality of the *chok* statements in this period, combined with their joint appearance with 'bathing' rituals in Terminal Classic texts, it is very likely that the perception or the focus of these rituals changed during the Terminal Classic from the general purpose to more agricultural/rainmaking oriented rituals (Jobbová et al. 2018). Finally, the spatial distribution of *at* rituals and the matching Terminal Classic distribution of *chok* rituals in the moderately rain-fed zone, in some cases without surface water sources (Uxactun, Tikal, Jimbal, Caracol) and without easy access to groundwater, suggests that the 'bathing' rituals, as petitions for rain, might indeed have played a more important role during the dry periods, especially in areas of higher environmental risk (Jobbová et al. 2018).

Table 1. Monuments with written statements of 'bathing' or *at* ritual

Site name	Monument number	Clause date	Julian date	Season	Date C	Text date (dedication)	Gregorian date	Date M	Transcription
Tikal	Stela 40	9.1.13.0.0 6 Ajaw 8 Sotz'	17 June 468	June	468	9.1.13.0.0 6 Ajaw 8 Sotz'	18 June 468	468	ya-AT-ji?.. Paddlers
Copan	Stela 2	9.10.15.13 0 6 Ajaw 8 Mol	22 July 648	July	648	9.11.0.0.0 6 Ajaw 8 Mol	14 October 652	652	AT-ti-ji
Copan	Stela 12	9.11.0.0.0 12 Ajaw 8 Keh	9 October 652	October	652	9.11.0.0.0 12 Ajaw 8 Keh	14 October 652	652	ya-ti-ji Paddlers
Copan	Altar Stela 1	9.12.0.0.0 10 Ajaw 8 Yaxkin	26 June 672	June	672	9.12.0.0.0 10 Ajaw 8 Yaxkin	1 July 672	672	ya-ti-ji Paddlers
Copan	Altar H	9.13.0.0.0 8 Ajaw 8 Wo	13 March 692	March	692	9.13.0.0.0 8 Ajaw 8 Wo	18 March 692	692	ya-ti-ji
Tonina	Monument 134	9.13.5.0.0 1 Ajaw 3 Pop	15 February 697	February	697	9.13.5.0.0 1 Ajaw 3 Pop	20 February 697	697	ya-ti-ji Paddlers
Copan	Stela J west	9.13.10.0.0 7 Ajaw 3 Kumk'u	20 January 702	January	702	9.13.10.0.0 7 Ajaw 3 Kumk'u	26 January 702	702	ya-ti-ji Paddlers
Tonina	Monument 139	9.13.10.0.0 7 Ajaw 3 Kumk'u	20 January 702	January	702	9.13.10.0.0 7 Ajaw 3 Kumk'u	26 January 702	702	ya-ti-ji Paddlers
Tonina	Monument 56	9.13.15.0.0 13 Ajaw 18 Pax	25 December 706	December	706	9.13.15.0.0 13 Ajaw 18 Pax	31 December 706	706	ya-ti-ji Paddlers
Tonina	Monument 63	9.14.0.0.0 6 Ajaw 13 Muwan	29 November 711	November	711	?9.14.0.0.0 6 Ajaw 13 Muwan	5 December 711	711	ya-ti-ji Paddlers
Piedras Negras	Stela 3-right side	9.14.0.0.0 6 Ajaw 13 Muwan	29 November 711	November	711	9.14.0.0.0 6 Ajaw 13 Muwan	5 December 711	711	ya?-ti-ji Paddlers
Naranjo	Stela 2	9.14.0.0.0 6 Ajaw 13 Muwan	29 November 711	November	711	9.14.1.3.19 3 Kawak 2 Pop	16 February 713	713	yatij? Paddlers
Naranjo	Stela 23	9.14.0.0.0 6 Ajaw 13 Muwan	29 November 711	November	711	9.14.0.0.0 6 Ajaw 13 Muwan	29 November 711	711	ya-AT-ji Paddlers
Tonina	Monument 136	9.14.5.0.0 12 Ajaw 8 K'ank'in	2 November 716	November	716	9.14.5.0.0 12 Ajaw 8 K'ank'in	8 November 716	716	ya-AT?/ti?-ji? Paddlers
Guaquitepec	Stela 1	9.14.10.0.0 5 Ajaw 3 Mak	7 October 721	October	721	9.14.10.0.0 5 Ajaw 3 Mak	9 October 721	721	ya-ti-ji
Tonina	Monument 110	9.14.10.0.0 5 Ajaw 3 Mak	7 October 721	October	721	9.14.10.0.0 5 Ajaw 3 Mak	9 October 721	721	ya-AT-ji Paddlers
Tikal	Stela 24s	9.19.0.0.0 9 Ajaw 18 Mol	22 June 810	June	810	9.19.0.0.0 9 Ajaw 18 Mol	28 June 810	810	ya-AT-ji-?-Paddlers
Tikal	Stela 24f	9.19.0.0.0 9 Ajaw 18 Mol	22 June 810	June	810	9.19.0.0.0 9 Ajaw 18 Mol	28 June 810	810	ya-AT?-ji Paddlers
Ixlu	Altar 1	10.2.10.0.0 2 Ajaw 13 Chen	20 June 879	June	879	10.2.10.0.0 2 Ajaw 13 Chen	26 Jun 879	879	ya-AT-ji? Paddlers
Tonina	Frag. X	NA	NA	NA	NA	NA	NA	NA	ya-ti-ji
Tonina	Monument 42	NA	NA	NA	NA	NA	NA	NA	ya-ti-ji Paddlers
Tonina	Monument 138	NA	NA	NA	NA	NA	NA	NA	ya-ti-ji-Paddlers u-CHOK-wa
Copan	Papagayo	NA	NA	NA	NA	9.4.0.0.0 13 Ajaw 18 Yax	18 October 514	514	ya-AT-ji

Additional 4 monuments with iconographical depictions of "bathing" ritual

Site name	Monument	Clause date	Julian date	Season	Date C	Text (Dedication) date	Gregorian date	Date M	Transcription
Ixlu	Stela 1	10.1.10.0.0 4 Ajaw 13 K'ank'in	3 October	October	859	10.1.10.0.0 4 Ajaw 13 K'ank'in	9 October 859	859	depicted Paddler gods in clouds
Tikal	Stela 11	10.2.0.0.0 3 Ajaw 3 Keh	13 August 869	August	869	10.2.0.0.0 3 Ajaw 3 Keh	17 August 869	869	Depicted Paddler gods in clouds
Jimbal	Stela 1	10.2.10.0.0 2 Ajaw 13 Ch'en	20 June 879	June	879	10.2.10.0.0 2 Ajaw 13 Ch'en	26 Jun 879	879	depicted Paddler gods in clouds
Ixlu	Stela 2	10.2.10.0.0 2 Ajaw 13 Ch'en?	20 June 879	June	879	10.2.10.0.0 2 Ajaw 13 Ch'en?	26 June 879	879	depicted Paddler gods in clouds

Table 2. Monuments with written statements of 'scattering' or *chok* ritual

Site name	Monument number	Clause date	Julian date	Season	Date C	Text date (latest)	Gregorian date	Date M	Transcription
Yaxchilan	HS 1	8.17.2.12.5 4 Chikchan 18 Woh	10 June 379	June	379	9.16.10.0.0 1 Ajaw 3 Sip	17 March 761	761	**CHOK-? ch'a-ji?**
Quiriguá	Monument 26	9.3.0.0.0 2 Ajaw 18 Muwan	27 January 495	January	495	9.3.0.0.0 2 Ajaw 18 Muwan	30 January 495	495	**u-CHOK [ch'a]-ji**
Piedras Negras	Altar 1	9.4.0.0.0 13 Ajaw 18 Yax	14 October 514	October	514	? 9.13.0.0.0	18 March 692	692	**? CHOK-?-ya?**
Palenque	Palace XIX Throne W	9.6.7.0.0 7 Ajaw 8 K'ayab	9 February 561	February	561	9.15.5.0.0 10 Ajaw 8 Ch'en	26 July 736	736	**u-CHOK ch'a-ji**
Calakmul	Stela 33	9.7.10.0.0 6 Ajaw 13 Sak	12 October 583	October	583	9.11.5.0.0 5 Ajaw 3 Sak	18 September 657	657	**CHOK-ch'a?-ji?**
Calakmul	Stela 33	?9.8.0.0.0 5 Ajaw 3 Ch'en	20 August 593	August	593	9.11.5.0.0 5 Ajaw 3 Sak	18 September 657	657	**u-CHOK-wa ch'a-ji?**
Caracol	Stela 1	9.8.0.0.0 5 Ajaw 3 Ch'en	20 August 593	August	593	?9.8.0.0.0 5 Ajaw 3 Ch'en	24 August 593	593	**CHOK**
Naranjo	Altar 1	9.8.0.0.0 5 Ajaw 3 Ch'en	20 August 593	August	593	9.8.2.14.3 7 Ak'bal 11 Sotz'	23 May 596	596	**u-CHOK-?**
Caracol	Stela 6	9.8.10.0.0 4 Ajaw 13 Xul	29 June 603	June	603	9.8.10.0.0 Ajaw 13 Xul	4 July 603	603	**u-CHOK**
Caracol	Stela 3	9.9.10.0.0 2 Ajaw 13 Pop	16 March 623	March	623	9.10.0.0.0 1 Ajaw 8 Kayab	25 January 633	633	**CHOK-wa**
Altar de Sacrificios	Altar Stela 9	9.10.0.0.0 1 Ajaw 8 K'ayab	22 January 633	January	633	9.10.0.0.0 1 Ajaw 8 K'ayab	24 January 633	633	**u-CHOK**
La Honradez	Stela 4b	9.10.0.0.0 1 Ajaw 8 K'ayab	22 January 633	January	633	9.10.0.0.0 1 Ajaw 8 K'ayab	27 January 633	633	**u?-CHOK-wa**
Yaxchilan	Stela 3	9.10.16.10 13 7 Ben 16 Sek	5 June 649	June	649	NA	NA	NA	**CHOK-?**
Copan	Stela 3b	?9.11.0.0.0 12 Ajaw 8 Kej	9 October 652	October	652	?9.11.0.0.0 12 Ajaw 8 Kej	14 October 652	652	**CHOK?**
Copan	Stela 13	9.11.0.0.0 12 Ajaw 8 Kej	9 October 652	October	652	9.11.0.0.0 12 Ajaw 8 Kej	14 October 652	652	**u-cho-ko-wa ch'a**
Copan	Altar Stela5	9.11.0.0.0 12 Ajaw 8 Kej	9 October 652	October	652	9.11.15.0.0 4 Ajaw 13 Mol	28 July 667	667	**u-CHOK**
Copan	Altar Stela 5	9.11.0.0.0 12 Ajaw 8 Kej	9 October 652	October	652	9.12.0.0.0 10 Ajaw 8 Yaxk'in	1 July 672	672	**u-chok-??**
Palenque	Palace Tablet	9.11.0.0.0 12 Ajaw 8 Kej	9 October 652	October	652	9.14.8.14.15 9 Men 3 Yax	14 August 720	720	**u-CHOK-wa ch'a-ji**
Tonina	Monument 28	9.11.5.0.0 5 Ajaw 3 Sak	13 September 657	September	657	9.11.5.0.0 5 Ajaw 3 Sak	18 September 657	657	**u-CHOK ch'a?-ji?**
La Corona (Site Q)	Panel 3?	9.11.10.0.0 11 Ajaw 18 Ch'en	18 August 662	August	662	9.11.10.0.0 11 Ajaw 18 Ch'en	20 August 662	662	**u-BAH-ti-CHOK-ko-ji**
Rio Azul	Stela 2	9.11.10.0.0 11 Ajaw 18 Ch'en	18-Aug	August	662	9.11.10.0.0 11 Ajaw 18 Ch'en	August 662	662	**u-CHOK-wa?**
Copan	Stela 5	9.11.15.0.0 4 Ajaw 13 Mol?	23 July 667	July	667	9.11.15.0.0 4 Ajaw 13 Mol	28 July 667	667	**CHOK?**

Site name	Monument number	Clause date	Julian date	Season	Date C	Text date (latest)	Gregorian date	Date M	Transcription
Tonina	Monument 113	9.12.0.0.0 10 Ajaw 8 Yaxk'in	26 June 672	July	672	9.12.0.0.0 10 Ajaw 8 Yaxk'in	1 July 672	672	**u-CHOK-ch'a-ya?**
La Corona (Site Q)	Panel 1	?9.12.5.0.0 3 Ajaw 3 Xul	31 May 677	May	677	9.12.5.7.4 4 K'an 7 Mak	27 October 677	677	**u- CHOK**
Copan	Stela 6	9.12.10.0.0 9 Ajaw 18 Sotz'	5 May 682	May	682	9.12.10.0.0 9 Ajaw 18 Sotz'	10 May 682	682	**u-CHOK ch'a-ji?**
Tonina	Monument 8, side 3	9.12.10.0.0 9 Ajaw 18 Sotz'	5 May 682	May	682	9.12.10.0.0 9 Ajaw 18 Sotz'	7 May 682	682	**u-CHOK-wa**
Tonina	Monument 8, side 4	? 9.12.10.0.0 9 Ajaw 18 Sotz'	5 May 682	May	682	9.12.10.0.0 9 Ajaw 18 Sotz'	7 May 682	682	**u-CHOK- ?**
Tonina	Monument 111	9.12.16.3.12 5 Eb 20 Xul	14 June 688	June	688	9.13.0.0.0 8 Ajaw 8 Wo	18 March 692	692	**u-u-CHOK-wa ch'a-ji**
Aguateca	Stela 5	9.13.0.0.0 8 Ajaw 8 Woh	13 March 692	March	692	?9.13.0.0.0 8 Ajaw 8 Woh	18 March 692	692	**u-CHOK ch'a-ji**
Copan	Stela J West	9.13.10.0.0 7 Ajaw 3 Kumk'u	20 January 702	January	702	9.13.10.0.0 7 Ajaw 3 Kumk'u	26 January 702	702	**CHOK ch'a-ji**
Dos Pilas	Stela 1	9.13.15.0.0 13 Ajaw 18 Pax	25 December 706	December	706	9.13.15.0.0 13 Ajaw 18 Pax	31 December 706	706	**u-CHOK-wa ch'a-ji**
La Corona (Site Q)	HS 2 Block XI (El Peru, panel 8)	9.13.18.16.4 13 K'an 2 K'ank'in	29 October 710	October	710	?9.14.3.5.15? 13 K'an 2 K'ank'in	31 October 710	710	**CHOK-ka-ja**
Naranjo	Stela 23	9.13.18.9.15 1 Men 13 Yaxk'in	22 June 710	June	710	9.13.19.6.3 3 Ak'bal 16 Sip	12 April 711	711	**CHOK ti-PET-ni**
Dos Pilas	Stela 8	9.14.0.0.0 6 Ajaw 13 Muwan	29 November 711	November	711	9.12.0.10.11 13 Chuwen 19 K'ayab	25 January 673	673	**u-cho-ko-wa ch'a-ji**
Naranjo	Stela 30 back	9.14.3.0.0 7 Ajaw 18 K'ank'in	13 November 714	November	714	9.14.3.0.0 7 Ajaw 18 K'ank'in	19 November 714	714	**u-CHOK-ja?**
Dos Pilas	Stela 11	9.14.5.0.0 12 Ajaw 8 K'ankin	2 November 716	November	716	9.14.5.0.0 12 Ajaw 8 K'ankin	4 November 716	716	**u-CHOK-wa-ch'a-ji**
Dos Pilas	Stela 15	9.14.10.0.0 5 Ajaw 3 Mak	7 October 721	October	721	9.14.10.0.0 5 Ajaw 3 Mak	9 October 721	721	**u-CHOK-wa ch'a-ji**
Tonina	Monument 110	9.14.10.0.0 5 Ajaw 3 Mak	7 October 721	October	721	9.14.10.0.0 5 Ajaw 3 Mak	9 October 721	721	**u-CHOK-wa ch'a-ji?**
Tonina	Monument 7	9.14.17.9.0 1 Ajaw 3 Wo	27 February 729	February	729	9.14.17.9.0 1 Ajaw 3 Wo	5 March 729	729	**u-CHOK [ch'a]-ji**
Aguateca	Stela 3	9.15.0.0.0 4 Ajaw 13 Yax	16 August 731	August	731	9.15.0.0.0. 4 Ajaw 13 Yax	22 August 731	731	**u-CHOK [ch'a]-ji**
Aroyo de Piedra	Stela 2a	9.15.0.0.0 4 Ajaw 13 Yax	16 August 731	August	731	9.15.0.0.0 4 Ajaw 13 Yax	22 August 731	731	**u-CHOK-wa ch'a-[ji]**

Oxpemul	Stela 12	9.15.0.0.0 4 Ajaw 13 Yax	16 August 731	August	731	9.15.0.0.0 4 Ajaw 13 Yax	22 August 731	731	**u-CHOK-wa?**
Tikal	Stela 21	9.15.3.6.8 3 Lamat 6 Pax	6 December 734	December	734	9.15.5.0.0 10 Ajaw 8 Ch'en	26 July 736	736	**CHOK[i]-wa-ch'a-ji**
Tonina	Monument 164	9.15.3.15.5 11 Chikchan 18 Xul	1 June 735	June	735	9.15.5.0.0 10 Ajaw 8 Ch'en	26 July 736	736	**u-CHOK-ji**
Aguateca	Stela 2	9.15.5.0.0 10 Ajaw 8 Ch'en	20 July 736	July	736	9.15.5.0.0 10 Ajaw 8 Ch'en	26 July 736	736	**u-CHOK ch'a-ji**
Palenque	Palace XIX Throne W	9.15.5.0.0 10 Ajaw 8 Ch'en	20 July 736	July	736	9.15.5.0.0 10 Ajaw 8 Ch'en	26 July 736	736	**u-CHOK**
Aguateca	Stela 1	9.15.10.0.0 3 Ajaw 3 Mol	24 June 741	June	741	9.15.10.0.0 3 Ajaw 3 Mol	30 June 741	741	**u-CHOK ch'a-ji**
Aguateca	Stela 1	9.15.9.9.0 5 Ajaw 8 K'ayab	26 December 740	December	741	9.15.10.0.0 3 Ajaw 3 Mol	30 June 741	741	**u-CHOK-wa ch'a-ji**
Dos Pilas	Bench 01	9.15.9.9.0 5 Ajaw 8 K'ayab	26 December 740	December	741	9.15.10.17.15 7 Men 13 Yaxk'in	20 June 742	742	**CHOK-wa ch'a-ji**
Moral	Altar 2	9.15.10.0.0 3 Ajaw 3 Mol	24 June 741	June	741	?9.15.8.14.9 1 Muluk 17 Sotz'	?25 April 740	740	**u-CHOK ?**
Nim Li Punit	Stela 1	9.15.10.0.0 3 Ajaw 3 Mol	24 June 741	June	741	9.15.10.0.0 3 Ajaw 3 Mol	30 June 741	741	**u-CHOK ch'a-ji**
Dos Pilas	Stela 4	9.15.11.0.0 12 Ajaw 18 Yaxk'in	19 June 742	June	742	9.15.11.0.0 12 Ajaw 18 Yaxk'in	23-Jun	742	**u-CHOK-wa ch'a-ji**
Piedras Negras	Stela 40	9.15.14.9.13 11 Ben 16 Pax	13 December 745	December	745	9. 15.15.0.0 9 Ajaw 18 Xul	4 June 746	746	**CHOK [ch'a-ji]**
Piedras Negras	Stela 40	9.15.15.0.0 9 Ajaw 18 Xul	29 May 746	May	746	9. 15.15.0.0 9 Ajaw 18 Xul	4 June 746	746	**CHOK [ch'a-ji]**
Quiriguá	Stela S	9.15.15.0.0 9 Ajaw 18 Xul	29 May 746	May	746	9.15.15.0.0 9 Ajaw 18 Xul	4 June 746	746	**u-CHOK ?**
Seibal	HS 1	9.15.14.17.18 7 Etz'nab 16 Xul	29 May 746	May	746	9.16.0.0.0 2 Ajaw 13 Sek	5 May 751	751	**u-CHOK-wa ch'a-ji**
Seibal	HS 1	9.15.15.0.0 9 Ajaw 18 Xul	29 May 746	May	746	9.16.0.0.0 2 Ajaw 13 Sek	5 May 751	751	**u-CHOK-wa-ch'a-ji**
Calakmul	Stela 62	9.16.0.0.0 2 Ajaw 13 Sek	3 May 751	May	751	9.16.0.0.0 2 Ajaw 13 Sek	9 May 751	751	**CHOK?**
Quiriguá	Stela H East	9.16.0.0.0 2 Ajaw 13 Sek	3 May 751	May	751	9.16.0.0.0 2 Ajaw 13 Sek	5 May 751	751	**u-CHOK? ch'a-ji**
Quiriguá	Stela J East	9.16.5.0.0 8 Ajaw 8 Sotz'	6 April 756	April	756	9.16.5.0.0 8 Ajaw 8 Sotz'	8 April 756	756	**u-CHOK-ji**
Quiriguá	Stela F East	9.16.10.0.0 1 Ajaw 3 Sip	11 March 761	March	761	9.16.10.0.0 1 Ajaw 3 Sip	13 March 761	761	**cho-ka-ja-ch'a-ji**
Sacul	Stela 1	9.16.10.0.0 1 Ajaw 3 Sip	11 March 761	March	761	9. 16.10.0.0 1 Ajaw 3 Sip	17 March 761	761	**u-CHOK ch'a-[ji]**
Yaxchilan	Stela 1	9.16.10.0.0 1 Ajaw 3 Sip	11 March 761	March	761	9.16.10.0.0 1 Ajaw 3 Sip	17 March 761	761	**u-CHOK**
La Pasadita	Lintel 2	9.16.15.0.0 7 Ajaw 18 Pop	13 February 766	February	766	9.16.15.0.0 7 Ajaw 18 Pop	19 February 766	766	**u-CHOK-wa**

(*Continued*)

Site name	Monument number	Clause date	Julian date	Season	Date C	Text date (latest)	Gregorian date	Date M	Transcription
Quiriguá	Stela D East	9.16.15.0.0 7 Ajaw 18 Pop	13 February 766	February	766	9.16.15.0.0 7 Ajaw 18 Pop	19 February 766	766	**u-CHOK-wa ch'a-ji**
Quiriguá	Stela D West	9.16.15.0.0 7 Ajaw 18 Pop	13 February 766	February	766	9.16.15.0.0 7 Ajaw 18 Pop	19 February 766	766	**u-cho-ko-wa ch'a-ji**
Tikal	Stela 22f	9.16.17.16.4 11 K'an 12 K'ayab	23 December 768	December	768	9.17.0.0.0 13 Ajaw 18 Kumk'u	24 January 771	771	**CHOK[i] ch'a-ji**
Oxpemul	Stela 2	9.17.0.0.0 13 Ajaw 18 Kumk'u	18 January 771	January	771	9.17.0.0.0 13 Ajaw 18 Kumk'u	24 January 771	771	**u-CHOK-wa**
Pomoná	Panel 1	9.17.0.0.0 13 Ajaw 18 Kumku	18 January 771	January	771	9.17.0.0.0 13 Ajaw 18 Kumku	24 January 771	771	**u-CHOK-wa ch'a-ji**
Quiriguá	Stela E East	9.17.0.0.0 13 Ajaw 18 Kumk'u	18 January 771	January	771	9.17.0.0.0 13 Ajaw 18 Kumk'u	20 January 771	771	**u-CHOK-ch'a-ji?**
Quiriguá	Stela E West	9.17.0.0.0 13 Ajaw 18 Kumk'u	18 January 771	January	771	9.17.0.0.0 13 Ajaw 18 Kumk'u	20 January 771	771	**CHOK-wa ch'a-ji**
Quiriguá	Stela C West	9.17.5.0.0 6 Ajaw 13 K'ayab	23 December 775	December	775	9.17.5.0.0 6 Ajaw 13 K'ayab	25 December 775	775	**u-CHOK-wa**
Bonampak	Stela 1	9.17.10.0.0 12 Ajaw 8 Pax	26 November 780	November	780	9.17.10.0.0 12 Ajaw 8 Pax	2 December 780	780	**u-CHOK-ch'a-ji**
Ixkun	Stela 2	9.17.9.6.14 7 Hix 2 Sek	14 April 780	April	780	(IS) 9.17.9.0.13 3 Ben 6 K'ayab	21 December 779	779	**u-CHOK**
Ixtzutz	Stela 4	9.17.10.0.0 12 Ajaw 8 Pax	26 November 780	November	780	9.17.10.0.0 12 Ajaw 8 Pax	2 December 780	780	**u-CHOK-ko-wa ch'a-ji**
Naranjo	Stela 33	9.17.10.0.0 12 Ajaw 8 Pax	26 November 780	November	780	9.17.10.0.0 12 Ajaw 8 Pax	28 November 780	780	**u-CHOK**
Naranjo	Stela 19	9.17.10.0.0 12 Ajaw 8 Pax	26 November 780	November	780	9.17.10.0.0 12 Ajaw 8 Pax	28 November 780	780	**u-CHOK**
Bonampak	Stela 3	9.17.15.0.0 5 Ajaw 3 Muwan	31 October 785	October	785	9.15.15.3.13 13 Ben 16 Kumk'u	18 January 786	786	**u-CHOK ch'a-ji**
Quiriguá	Altar O' c	9.17.15.0.0 5 Ajaw 3 Muwan	31 October 785	October	785	9.18.0.0.0 11 Ajaw 18 Mak	11 October 790	790	**u-u-CHOK-wa ch'a-ji**
Tikal	Stela 19f	9.17.18.3.1 2 Imix 9 K'ayab	15 December 788	December	788	9.18.0.0.0 11 Ajaw 18 Mak	11 October 790	790	**CHOK-wa-?**
Ixkun	Stela 4	?9.17.18.7.6 9 Kimi 9 Sip	10 March 789	March	789	?9.17.18.7.6 9 Kimi 9 Sip	16 March 789	789	**u?-CHOK?**
Ixkun	Stela 1	9.18.0.0.0 11 Ajaw 18 Mak	5 October 790	October	790	(IS) 9.18.0.0.0 11 Ajaw 18 Mak	11 October 790	790	**u-CHOK**
Ixkun	Stela 1	9.18.0.0.0 11 Ajaw 18 Mak	5 October 790	October	790	(IS) 9.18.0.0.0 11 Ajaw 18 Mak	11 October 790	790	**CHOK ch'a?-?**
Ixkun	Stela 1	9.18.0.0.0 11 Ajaw 18 Mak	5 October 790	October	790	(IS) 9.18.0.0.0 11 Ajaw 18 Mak	11 October 790	790	**ti-CHOK ch'a-ji?**

Naranjo	Stela 14	9.18.0.0.0 11 Ajaw 18 Mak	5 October 790	October	790	9.18.0.0.0 11 Ajaw 18 Mak	7 October 790	790	**u-CHOK-wa ch'a-[ji?]**
Nim Li Punit	Stela 21	9.18.0.0.0 11 Ajaw 18 Mak	5 October 790	October	790	9.18.0.0.0 11 Ajaw 18 Mak	11 October 790	790	**u-CHOK-wa**
Yaxha	Stela 13	9.18.3.0.0 12 Ajaw 3 Mak	19 September 793	September	793	9.18.3.0.0 12 Ajaw 3 Mak	21 September 793	793	**u-CHOK-wa? ch'a**
Quiriguá	Altar P'	9.18.5.0.0 4 Ajaw 13 Kej	9 September 795	September	795	9.18.5.0.0 4 Ajaw 13 Kej	11 September 795	795	**cho-ko-wa ch'a-ji**
Quiriguá	Zoo P north cartouche	9.18.5.0.0 4 Ajaw 13 Kej	9 September 795	September	795	9.18.5.0.0 4 Ajaw 13 Kej	11 September 795	795	**u-CHOK-ch'a**
Quiriguá	Zoo P south	9.18.5.0.0 4 Ajaw 13 Kej	9 September 795	September	795	9.18.5.0.0 4 Ajaw 13 Kej	11 September 795	795	**u-CHOK-wa ch'a-ji**
Tonina	Monument 34	9.18.5.0.0 4 Ajaw 13 Kej	9 September 795	September	795	9.18.5.0.0 4 Ajaw 13 Kej	11 September 795	795	**u-CHOK?**
Caracol	Stela 11	9.18.10.0.0 10 Ajaw 8 Sak	13 August 800	August	800	9.18.10.0.0 10 Ajaw 8 Sak	19 August 800	800	**u-CHOK-ch'a?-ji?**
Nim Li Punit	Stela 14	9.18.10. 0.0 10 Ajaw 8 Sak	13 August 800	August	800	9.18.10.0.0 10 Ajaw 8 Sak	17 August 800	800	**u-CHOK- ?**
Quiriguá	Stela I north	9.18.10.0.0 10 Ajaw 8 Sak	13 August 800	August	800	9.18.10.0.0 10 Ajaw 8 Sak	15 August 800	800	**u-CHOK-ji**
Quiriguá	Stela K south	9.18.15.0.0 3 Ajaw 3 Yax	18 July 805	July	805	9.18.15.0.0 3 Ajaw 3 Yax	20 July 805	805	**u-CHOK-?**
Quiriguá	Structure 1B-1	9.19.0.0.0 9 Ajaw 18 Mol	22 June 810	June	810	9.19.0.0.0 9 Ajaw 18 Mol	24 June 810	810	**u-CHOK-ko-wa**
Quiriguá	Structure 1B-1	9.19.0.0.0 9 Ajaw 18 Mol	22 June 810	June	810	9.19.0.0.0 9 Ajaw 18 Mol	24 June 810	810	**u-CHOK-ko-wa**
Uaxactun	Stela 7	9.19.0.0.0 9 Ajaw 18 Mol	22 June 810	June	810	9.19.0.0.0 9 Ajaw 18 Mol	28 June 810	810	**?- ch'a**
Caracol	Altar 12	9.19.10.0.0 8 Ajaw 8 Xul	30 April 820	April	820	9.19.10.0.0 8 Ajaw 8 Xul	6 May 820	820	**u-CHOK-wa?**
Itzan	Stela 6	9.19.19.16.0 6 Ajaw 18 Pop	28 January 830	January	830	9.19.19.16.0 6 Ajaw 18 Pop	21 Oct 822	822	**u-CHOK-wa? ch'a-ja**
Tonina	Monument 104	10.0.7.9.0 3 Ajaw 3 Sak	30 July 837	July	837	10.0.7.9.0 3 Ajaw 3 Sak	1 August 837	837	**u-CHOK [ch'a]-ji**
Caracol	Stela 17	10.1.0.0.0 5 Ajaw 3 K'ayab	24 November 849	November	849	10.1.0.0.0 5 Ajaw 3 K'ayab	30 November 849	849	**u-CHOK ch'a-?**
Seibal	Stela 10	10.1.0.0.0 5 Ajaw 3 K'ayab	24 November 849	November	849	10.1.0.0.0 5 Ajaw 3 K'ayab	30 November 849	849	**u-CHOK-ko-wa**
Ucanal	Stela 4?	10.1.0.0.0 5 Ajaw 3 K'ayab	24 November 849	November	849	10.1.0.0.0 5 Ajaw 3 K'ayab	30 November 849	849	**u-CHOK-wa**
Ixlu	Stela 1	10.1.10.0.0 4 Ajaw 13 K'ank'in	3 (7) October 859	October	859	10.1.10.0.0 4 Ajaw 13 K'ank'in	9 October 859	859	**u-CHOK-?-wa**
Tikal	Stela 11	10.2.0.0.0 3 Ajaw 3 Keh	13 August 869	August	869	10.2.0.0.0 3 Ajaw 3 Keh	17 August 869	869	CHOK depicted

(*Continued*)

Site name	Monument number	Clause date	Julian date	Season	Date C	Text date (latest)	Gregorian date	Date M	Transcription
Ixlu	Altar 1	10.2.10.0.0 2 Ajaw 13 Ch'en	20 June 879	June	879	10.2.10.0.0 2 Ajaw 13 Ch'en	26 June 879	879	**u-CHOK-ko-wa ch'a-ji**
Jimbal	Stela 1	10.2.10.0.0 2 Ajaw 13 Ch'en	20 June 879	June	879	10.2.10.0.0 2 Ajaw 13 Ch'en	26 Jun 879	879	**u-CHOK-ko-wa ch'a-ji**
Ixlu	Stela 2	10.2.10.0.0 2 Ajaw 13 Ch'en	20 June 879	June	879	10.2.10.0.0 2 Ajaw 13 Ch'en	26 June 879	879	CHOK depicted
Jimbal	Stela 2	10.3.0.0.0 1 Ajaw 3 Yaxk'in	28 April 889	April	889	10.3.0.0.0 1 Ajaw 3 Yaxk'in	4 May 889	880	**u-CHOK**
Uaxactun	Stela 12	10.3.0.0.0 1 Ajaw 3 Yaxk'in	28 April 889	April	889	10.3.0.0.0 1 Ajaw 3 Yaxk'in	4 May 889	889	**CHOK-?-ja**
Tonina	Monument 158	10.3.15.0.0 6 Ajaw 8 Sip	9 February 904	February	904	10.3.17.9.0 9 Ajaw 18 Sak	30 July 906	906	**u-CHOK-wa**
Copan	?Img0075	NA	NA	NA	NA	NA	NA	NA	**u-CHOK-wa ch'a-ji**
El Palmar	Stela 18	? 10 Ajaw 8 Sak	NA	NA	NA	NA	NA	NA	**u-CHOK-ch'a**
Coba	Stela 1	NA	NA	NA	NA	9.12.10.5.12 4 Eb 10 Yax	25 August 682	682	**? U-CHOK-? ch'a-ji?**
Jimbal	Stela 1	? Teotihuacan date?	NA	NA	NA	NA	NA	NA	**u-CHOK-ko?-ja**
Nim Li Punit	Stela 4	NA	NA	NA	NA	NA	NA	NA	**?-CHOK?**
Tortuguero	pSARC00	NA	NA	NA	NA	NA	NA	NA	**u-CHOK-?**
El Peru	Stela 39 sides	NA	NA	NA	NA	NA	NA	NA	**u-CHOK-wa?**
Jimbal	Stela 1	NA	NA	NA	NA	10.2.10.0.0 2 Ajaw 13 Ch'en	26 Jun 879	879	**u-CHOK ch'a-ji**
Lubaantun	Marker 2	NA	NA	NA	NA	9.18.0.0.0 11 Ajaw 18 Mak	11 October 790	790	**u-CHOK-wa**
Quiriguá	Stela A	millions of years	NA	NA	NA	9.17.5.0.0 6 Ajaw 13 K'ayab	29 December 775	775	**u-CHOK-ch'a**
Tonina	Monument 138	NA	NA	NA	NA	NA	NA	NA	**u-CHOK-wa**
Tonina	Monument 137	?6 Imix 9 Muwan - much earlier or much later?	Very early date	NA	NA	9.15.5.0.0 10 Ajaw 8 Ch'en	26 July 736	736	**u-CHOK-wa**
Tonina	Monument 99	NA	NA	NA	NA	NA	NA	NA	CHOK-?

9

Two Millennia of Human Response to Environmental Stress in the Maya Lowlands: Interweaving Narratives

9.1. Introduction

Climate change, environmental stress and the accompanying responses of human society are undeniably among the most relevant and debated topics today. Despite this focus and new analytical opportunities provided by methodological developments in various disciplines, little is known about either the short- or long-term dynamics of past human-environment relationships, especially with respect to how and to what extent responses to environmental stress can be considered a driver in the cultural trajectory of a particular region.

As discussed in Chapter 4, one of the key aspects in the way humans respond to perturbations, such as environmental stress, is the potential for change, that is, the range of options people have available to deal with unfavourable conditions. Another important aspect is how connected the controlling variables and processes are and, therefore, how flexible the system is (Holling and Gunderson 2002:32–33). Whether the variables are social, economic, political or ritual, their greater interconnectedness leads to greater inflexibility or rigidity of the system and, therefore, increased vulnerability to unexpected or unpredictable shocks (in other words, a decreased resilience of a system, see Holling and Gunderson 2002:32–33).

In the previous chapters, I attempted to explore how the modern and the ancient Maya interacted with their local environments, using different perspectives, different temporal and spatial scales, and taking into account different environmental conditions. This allowed me to investigate human responses by taking into account both environmental conditions, as well as social, political and economic histories. More importantly, it allowed me to begin exploring the links between these various factors and avoid a frequent pitfall of many previous studies of human-environmental relationships in Maya archaeology: the lack of integration among relevant fields such as archaeology, anthropology, epigraphy, geology, palaeoclimatology and palaeoecology.

The ethnographic chapter (Chapter 4) provided exploratory groundwork and focused especially on human responses to spatial and temporal variation in weather and environmental stress on the individual and household scale, on a day-to-day basis. The observations gained from ethnographic fieldwork among contemporary Maya communities – about how events such as droughts, floods, hurricanes or locusts affect people's lives, how people react to these events and what coping strategies they develop in response – then served as a guide to detect similar patterns in the archaeological and textual evidence discussed in the following chapters. Chapter 5 explored palaeoclimatic records to examine the variation and long-term change in weather patterns within the wider case study regions. Use of proxies that were as geographically relevant as possible allowed for examination of effects that environmental/climate change would have had in different regions and, consequently, on people's ability to deal with these changes. Chapter 6, focusing on settlement, investigated changes in occupation rates and settlement patterns and distribution through time; it also explored the possible relationship between these changes and changes in climate/environment, as well as socio-political and cultural changes in Maya society. Settlement changes and their possible links to both climate/environmental variation and cultural and social factors, were then further explored in Chapter 7, which focused on development and changes in agricultural and water management strategies. Whereas Chapters 5, 6 and 7 relied mainly on archaeological and environmental evidence, Chapter 8 was based predominantly on textual evidence, drawn from Maya hieroglyphic inscriptions. The chapter looked closely at the cultural and political history of Maya society and considered factors such as ideology, and social and political interactions. In addition, Chapter 8 further explored human responses to environmental stress by focusing on one specific coping strategy, ritual activity, during the Classic and especially the Terminal Classic period.

The goal of this chapter is to synthesise the results of analyses and observations from the six previous chapters and to address some of the questions articulated in Chapter 2: How did the Maya deal with the environmental stress of what in the literature has been characterised as drought? Where we have records of adverse rainfall conditions, is the response to stress evident in settlement patterns, agricultural and water management strategies, or in the written records? What can we learn about the relationship between Maya society and the environment by examining a range of evidence over the long term and in different regions?

9.2. Interweaving narratives and evidence

This exploratory journey started with the premise that it is not 'climate change' but weather that people react and respond to on a day-to-day basis (Pillat 2012), and eventually adapt to over the long term (Smit and Wandel 2006). How, then, do people respond to weather changes,

especially to potentially stressful or dangerous events, such as droughts, floods, fires and hurricanes? How are these changes perceived and experienced; are they remembered on a long-term scale (when they become a long enough term patterns, which we call climate change) and if so, how is this information stored and transmitted?

Answers to the first part of the question, how do people respond and what choices do they make, are, in this study, drawn from ethnographic fieldwork conducted among the contemporary Maya communities in Belize (Downey and Jobbová 2011), during which we interviewed people about historical weather variability, drought and adjustments to changing weather patterns. The results of this fieldwork are discussed in detail in Chapter 4, so here I would only like to point out the most important observations. One of the insights gained is the fact that drought is a real phenomenon even in the humid tropics, where abundance of water is often assumed, at least by people from temperate climates. The interviews showed that, especially for agricultural communities, events such as floods, hurricanes, droughts or locusts have real impact on peoples' lives and can sometimes have severe consequences.

It also became obvious, however, that in some cases the events themselves are only part of the problem, and that it is often the way how the events make people vulnerable and easily exploited that has the most serious or long-lasting consequences. It is, therefore, not surprising that people remember such events for a long time and are able to perceive long-term weather patterns (30 years or more). This was not only seen from the general consensus in people's answers to questions about weather changes that the weather is getting hotter, drier and generally less predictable, it was also supported by the results of analyses conducted on modern rainfall data from the case study areas. It also became obvious that many different coping strategies have been developed over time to deal with stressful weather and environmental events. These include changes in subsistence strategies, at least temporarily (for example, hunting and wild food gathering), changes in agricultural strategies (for example, adjusted planting schedule, use of different crops, mechanisation of agriculture), seeking wage-labour and help from the government (if possible), and increased ritual activity.

Another important observation is that the impact and, consequently, the perception of environmental events vary in different areas and so do coping strategies. Differences are often due to environmental conditions (for example, variation in rainfall, types of soils, water access); in other cases responses are affected by cultural, social (ethnic backgrounds, beliefs) and economic factors (resources, opportunities for work). If we use these observations as a guide when looking for similar patterns in archaeological and textual evidence, is it possible to detect choices that people made when facing these events in the past?

9.2.1. Coping strategies in the written and archaeological records

One of the coping mechanisms revealed by ethnographic research was the use of rituals – a variety of religious ceremonies related to extreme climatic events, drought in particular, were still being performed, or are at least remembered, by people in both the Cayo and Toledo districts. Religious ceremonies were also the aspect in which the two regions differed the most. Considering the differences, it is interesting that people in both the Cayo and Toledo districts reported the 'bathing' ritual, the only one of the rain-calling ceremonies shared by both regions. In addition, the same ritual appears in early ethnographic research, providing a link between the contemporary rain-calling rituals and those performed during the 1920s. Such shared knowledge and consistency indicates that there might be a much longer continuity in these rain-calling rituals. As discussed in Chapter 8, not only are there past and present ethnographic parallels from other tropical environments, such as in Southeast Asian countries, but it is very likely that the 'bathing' ritual dates back to the Classic Maya period and can be identified on ancient Maya monuments, especially those from the Terminal Classic period. In addition to the 'bathing' ritual, a scattering ritual may be another precursor to the present-day agriculturally-oriented/rain-making ceremonies. The association with agriculture and the rain-calling nature of these two ancient rituals is supported by their highly seasonal nature (corresponding with rainy seasons), and by their temporal and spatial distribution. The results of analyses discussed in detail in Chapter 8 indicate that 'bathing' rituals, as petitions for rain, might indeed have played a more important role during the dry periods, especially in areas with higher environmental stress (zones with moderate rainfall and perhaps shifting rainfall regimes, and without easy access to groundwater). The results also suggest that the perception or focus of *chok*, or scattering rituals, changed during the Terminal Classic from a general-purpose ritual to one oriented towards agricultural fertility and rainmaking, possibly as a reflection of the presence of droughts or periods with diminished precipitation. This change is indicated by the increased frequency of *chok* rituals corresponding chronologically with the onset of the period with adverse rainfall conditions during the Terminal Classic, their increase in seasonality, and their joint appearance with the 'bathing' rituals during this period.

We also see other changes taking place during the periods highlighted by peaks in the occurrence of 'bathing' and scattering rituals. By AD 800, war narratives disappear; texts become short and formulaic, and focus mostly on ritual activity and celebrations of period endings. After AD 800, rituals, at least as portrayed on monuments, are being performed jointly by groups of rulers/nobles some of them from sites that used to be in adversarial relationships. This was described by Grube (2013) as people returning to what they knew worked before – ritual activity. It is possible that with ideological changes taking place at this time,

people returned to ritual activity that had been prominent during the Middle Preclassic period, before the concept of divine kingship was widely established. Possible change in the perception of the concept of rulership is supported by contemporary changes in the composition and iconography of stelae, with a de-emphasis on the king as sole autocratic ruler, an increased emphasis on so-called confrontation/conversation scenes in which power-sharing and decentralisation of power are apparent in the inclusion of multiple actors, especially pairs (Chase 1983b: 105–110), and the appearance of emblem glyphs and other royal titles at formerly secondary centres (Martin and Grube 2000: 98–99; Valdés and Fahsen 2004; Rice and Rice 2004: 133–134; Zrałka 2008: 200). In addition, there are changes in settlement patterns (although this varies depending on the area) and, in many cases, a decrease in population coupled with more informal settlement organisation (for the Belize River Valley, see Ford 1990; Ford and Fedick 1992; LeCount and Yaeger 2010; Hoggarth 2012; Willey et al. 1965; for the Peten Lakes see Rice and Rice 1980, 2004; Rice 1986). This variety of changes then warrants considering whether or not all of these changes reflect responses to environmental stress, or are there other factors at play?

9.2.2. Political disintegration

By the end of the Late Classic period, many primary sites stopped erecting monuments altogether. Instead, monuments commissioned by former secondary centres bear emblem glyphs and royal titles, in some cases, even using emblem glyphs of the primary centres (for example, Tikal and Copan). This situation indicates the instability or political weakness of the former superpowers of Maya area (Martin and Grube 1995; Valdés and Fahsen 2004; Zrałka 2008: 200). The ability of the smaller and formerly subordinate centres to appropriate power or claim independence, and even flourish for some time during the Terminal Classic (or Postclassic), might indicate that they were not completely economically subordinated and dependent on their 'hegemons' (Zrałka 2008: 20).

We see a related pattern in settlement data, in which the smaller sites survive or even thrive longer than the larger sites, in some cases until the Late Postclassic period. The self-sufficiency of relatively small sites, such as Baking Pot or Barton Ramie, given their position along the fertile Belize River Valley, might have provided them with relative economic and, perhaps, even political independence (at least once, the major regional centres, such as Caracol and Naranjo, lost their power and the system of allegiances and hierarchical networks fell apart during the Terminal Classic and Early Postclassic period), and might have played role in their comparatively late survival.

Prior to the political disintegration, however, these intermediate sites in the Belize River Valley were a part of hierarchical networks of alliances characteristic of the period, and the valley and its resources would have been too valuable not to be of interest and were most likely subjected to the competition for control and resources between Naranjo and Caracol throughout the Classic period. Competition likely escalated as the warfare between the large centres intensified during the Late Classic and the demand for food increased (Ashmore 2010: 61). Xunantunich, with its extensive agricultural terraces, may have been more of a target for Naranjo and Caracol in such competition than other sites in the Belize Valley. This hypothesis is supported by Naranjo's contacts with Belize Valley sites, especially with Xunantunich, during the Late Classic (AD 692–820; Helmke and Awe 2012: 83) and by the mild general trend in Belize Valley occupation rates, which shows decrease in a west-east direction during the Late Classic and Postclassic period. That is, the sites in the west, such as Xunantunich, were abandoned earlier than those in the east, such as Baking Pot or Barton Ramie.

It is also possible that as the kings of these large centres strived to save their kingdoms, they tried to implement a new political model that was based on small semi-autonomous polities, with the governors of secondary centres possibly sharing power, replacing the centralised rulership of the king (Valdés and Fahsen 2004: 151; Graham 2016). This possible change in rulership style might be, in fact, directly related to the Terminal Classic change in stelae composition and iconography to the multi-figure, conversational scenes featuring the ruler and non-royal elites, such as subsidiary governors and titled courtiers, or sometimes figures whose statuses are not clear. Conversational and diplomatic scenes also often appear on Terminal Classic Fine Orange vessels of the Pabellon moulded-carved type (Helmke 2001; Helmke and Reents-Budet 2008; Rice and Rice 2004: 133–134; Ting 2013), and Prudence and Don Rice suggest that these vessels may have been used for serving food and drinks during such gatherings. Interestingly, archaeological investigations both at Xunantunich and Baking Pot show that large-scale community feasting became more prominent during the Terminal and Early Postclassic period, as non-royal noble households attempted to create new relationships and forms of interactions with commoner households in order to foster community solidarity and interaction during the time of social and political instability (see LeCount 1999, 2001; Hoggarth 2012).

The described changes – the emergence of secondary or non-traditional elites and the change in the portrayal of the relationship between the ruler and subsidiary nobles – reflect considerable ideological changes and political problems. The shift in both the inscriptions and the stela art from a focus on the ruler with considerable power and authority to conversational and diplomatic scenes suggests that the centralised system of royal power was replaced by power-sharing, the power being devolved to the elite lords. This led not only to practical change in the way power was exercised, but could perhaps have even changed the perception of the concept of power (Zrałka 2008: 212–213). The authority of the dynastic ruler declined, probably resulting in the cessation of monuments in some sites and the appearance of multi-figural conversational scenes on

late monuments in others (Martin and Grube 2000: 98–99; Zrałka 2008: 212–213). In many sites (for example, Nakum, Yaxha and Xunantunich), the decline of dynastic rule was accompanied by a decrease in monumental construction and by demographic decline (see Zrałka 2008: 213; Ehret 1995).

Epigraphic evidence indicates that hierarchical relationships between at least some sites existed in the northern lowlands as well, but it also suggests the existence of a different concept or perception of divine kingship from what characterised the southern lowlands and perhaps less political competition within society (for example, fewer emblem glyphs with those in existence being used in different ways and perceived differently than in the southern lowlands, Graña-Behrens 2006: 120). Although the idea of northern lowland sites operating within a *multepal or a* 'joint rule' political system has been rejected by epigraphers, evidence from Mayapan suggests that some sort of power sharing may have existed. Settlement at Mayapan was distributed around two ceremonial/administrative centres, with the important ritual and administrative functions possibly being shared between them (Russell 2008: 669). Therefore, although some of the changes detected in the southern lowlands (ritual focus of texts, foreign features, settlement changes, demographic decline albeit with slightly different chronology) can also be detected in the northern lowland sites, their political and environmental heterogeneity (in comparison to southern lowlands centres) might have played a role in their different cultural trajectory (different environmental conditions, subsistence and water management strategies are discussed below).

Exploring the issue of political disintegration further, we can again see parallels in settlement patterns. There is a significant change in settlement organisation between the Classic and the Postclassic periods. Increased nucleation and formalisation of settlement structure during the Late Classic period, often associated with political centralisation during this time, gives way to less formal organisation of settlement and a return to solitary structures during the Postclassic period (see Sabloff 1996; Rice and Rice 1980). In the Belize Valley, some level of centralisation/planning and top-down control during the Late Classic might be indicated by evidence of the directional and rectilinear pattern of the settlement at Baking Pot and Barton Ramie (Bevan et al. 2013). Similar rectilinear patterns can be observed in the Late Classic agricultural and water management features at some sites (Caracol, Baking Pot). In contrast, the Postclassic population found in the Belize Valley is relatively low and dispersed. The Peten Lakes area, on the other hand, experienced a growth in population during the Postclassic, with surviving and some newly-established settlements organised into small, densely settled and nucleated communities located on islands and lake peninsulas. However, there seems to be an apparent disregard for inter-structure alignment and orientation in the Postclassic Peten sites (Johnson 1985: 152) and the formal organisation into patio groups typical for the Classic period is rare. Instead, solitary structures more typical of Preclassic settlement are common (Rice and Rice 1980: 451). In addition, there is virtually no evidence of reoccupation of the previous phase architecture in the Yaxha-Sacnab basin during the Postclassic period (Rice and Rice 1980).

This pattern seems to be shared by Postclassic settlements at sites in different regions as well. Manahan and Canuto (2009: 567) mention the same pattern for the Copan Valley and David Pendergast and colleagues note that the Postclassic community centres in Belize seem to have skirted or even avoided areas with concentrated Classic-period buildings, and it also seems to apply to the Historic-period settlements locations (Pendergast et al. 1993: 65). This view might be slightly skewed, however, by underrepresentation of perishable structures that are difficult to identify. As noted by Graham (2004), evidence from Lamanai shows a return to perishable structures built on low stone platforms atop Classic structures in the Terminal Classic through Spanish colonial period. It is, therefore, likely that the nucleation into small communities during the Postclasic period in the Peten Lakes is of a different nature, and more related to the need for defence or access to markets, rather than to an increase in socio-political complexity. As discussed in Chapter 6, land scarcity (or famine) among swidden farmers can lead to warfare and is often accompanied by settlement nucleation (Ringle 1985: 337–339; Vayda 1961). Increased occupation of the Peten Lakes region during the Late Classic on one hand, and significantly decreased land availability at the same time on the other, makes such a scenario possible. Alternatively, the less ordered patio and plaza groups might also indicate short-term occupation, that is, by incoming people with no local longevity or with a very different sense of property rights in the local area (Andrew Bevan pers. comm. 2017).

In the northern lowlands, we see different patterns, however, especially during the Terminal Classic and the Postclassic period. Postclassic sites such as Tulum and Mayapan show evidence of planning and formal organisation of settlement, and in Mayapan's case, its two centres have been linked to a power-sharing form of government (Russell 2008). The existence of some form of centralisation in the northern lowland sites during the Terminal and Postclassic period might also be indicated by centralised control of use of houseplots at Cozumel and Xelha and several other sites during the Late Postclassic (Freidel and Sabloff 1984: 84–90), and by elite ownership of intensive agriculture features such as *rejolladas* during the Terminal and Postclassic period (Kepecs and Boucher 1996: 78; Lincoln 1991).

9.2.3. Demographic collapse

There are changes, however, that are not easily explained by political disintegration alone. It is not only population movements to lakes and coastal areas and lack of formal organisation (at least in the southern lowlands) that characterises settlement changes during the Terminal Classic period. Between the Late Classic and the Early

Postclassic period, a large majority of sites experienced a significant decrease in occupation. Even the Belize Valley and Peten Lakes regions, which are in many respects exceptions, and where some sites continue to be occupied until the late Postclassic, show considerable occupation decline. The occupation in the Xunantunich region during the Terminal Classic is less than 20% of the Late Classic population, and by the beginning of the Early Postclassic, it is abandoned. The occupation of the area covered by the Belize River Archaeological Settlement Survey (BRASS) decreased by 50% during the Terminal Classic and by 80% during the Postclassic. Only Barton Ramie and Baking Pot show occupation until the Middle-Late Postclassic period, although a hiatus in activity during the Early Postclassic has been suggested (Hoggarth et al. 2014). In the Peten Lakes region, Yaxha shows 11% of occupation during the Terminal Classic and it is abandoned by the Late Postclassic; Salpeten, Quexil, Petenxil and Cero Ortiz have similar fates.

It is only the small islands and lake peninsulas, such as Zacpeten Peninsula and Cante and Quexil Islands, that show an increase in occupation after the Late Classic, although Cante Island only grows after being abandoned during the Terminal Classic period and then reoccupied. Reoccupation after decline or abandonment can be also observed in Macanche and Nakum. Some of the other areas in the southern lowlands, such as the Pasion sites, show an initial increase in the Terminal Classic occupation, however, this seems to be short lived, as the Early Postclassic occupation rates are again very low; 28% of the Terminal Classic occupation at Altar de Sacrificios and 14% at Seibal (Rice and Culbert 1990: 34). Central and peripheral Tikal shows significant decrease in occupation already during the Terminal Classic and virtually no occupation during the Postclassic (4% and 1% respectively; Rice and Culbert 1990: 34). On the other hand, Pultrouser Swamp shows a slower rate of depopulation, with 90% of occupation during the Terminal Classic, but then abandonment during the Early Postclassic and reoccupation during the Late Postclassic period (Rice and Culbert 1990: 34).

Within discussions of demographic collapse during the Terminal Classic period, the site of Lamanai is something of an exception and is often presented as a Maya centre 'that did not collapse' (Aimers 2007: 348). This is due to unusual longevity of occupation at Lamanai, the beginning of which dates to circa 1500 BC (Hanna et al. 2016) and lasts until the late 17th century (Pendergast 1981, 1985, 1986; Graham 2004, 2011). Continuous occupation, however, does not mean that Lamanai did not experience any changes between the Late Classic and the Postclassic period. Graham (2019) in fact argues for the presence of repeated conflict and changes in nature of governance from the Late Classic through to the Postclassic period.

In the northern lowlands, many sites experienced a peak in occupation at the beginning of the Terminal Classic and almost complete abandonment by the end of it. Komchen reached its peak during the Late Classic/Terminal Classic period (Copo phase), but it is practically abandoned during the Early Postclassic period, with occupation being 1% of that during the Late/Terminal Classic. Popola and Dzibilchaltun show a similar pattern, with the Postclassic occupation rates 2 and 3% respectively, after experiencing a peak during the Late/Terminal Classic. On the other hand, Mayapan and San Gervasio show considerable growth during the Postclassic period.

When interpreting these numbers, a return to perishable structures, low 'hidden mounds' (that are difficult to identify and therefore the decline in population might be overestimated) and mobility need to be taken into account, but considerable demographic decline can hardly be overlooked or easily explained only by political disintegration. Neither does political disintegration and a shift in power wielding completely explain changes in the material culture, writing, art or architecture. Other explanations put forward include endemic warfare, foreign invasion and a peasant, or sometimes noble, revolt (see Demarest 1993, 2004b, 2006; Inomata 1997; Sabloff and Willey 1967; Sabloff 1973; Thompson 1931; Fash 1991). Others state that evidence for changes in rules of engagement in conflict, as well as the collapse of dynastic rule, argue strongly for the major stimulus behind the Classic to Postclassic transformations being conflict initiated by people from either inside or outside the Maya area (or both), who held cultural values and economic priorities different from – and at significant odds with – those perpetuated and sanctioned under Classic dynastic rule (Aoyama and Graham 2015; Graham 2019). The foreign element in the 'invasion' is based on the appearance of foreign features in architecture and iconography (for example, at Seibal and Machaquila) and on a hiatus between the Terminal Classic and Postclassic occupation, which has been observed in the Peten Lakes area and elsewhere (Nakum and Copan), and in-migration and reoccupation of these areas by people from different regions.

These foreign features, however, especially in coastal areas, could simply be the evidence of intensified trade and exchange, as the vast majority of surviving sites are located on important trade routes, maintaining contacts with other parts of Maya area such as Northern Yucatan, Copan Valley, and also other parts of Mesoamerica (Central Mexico and Gulf Coast regions). The hypothesis that many of these foreign features may just be a result of intensified trade rather than in-migration of people from different regions is supported by research in the Peten Lakes. Postclassic occupation has been said to reflect people migrating from northern Yucatan, but research shows continuity between Classic and Postclassic cultures and occupation of the Peten (D. Rice 1986, 1988; P. Rice 1986, 1987; P. Rice and D. Rice 1980, 1981, 1982, 1984a, b, 1985, 1990, 2004, 2009; Andrews 1993).

Before we look at some of these individual hypotheses in more detail, we will first look further back in Maya history, as this is not the first time we see some of the described patterns occurring in the Maya area.

9.3. Recurring patterns from the Preclassic to Classic to Postclassic

The Early Classic period (AD 250–600) shows a cessation of construction activity and even abandonment of many centres in the Maya area. As discussed in Chapter 6, in both study regions, many sites experienced a decrease or at least stagnation in occupation. For example, the Belize Valley area investigated by the BRASS project, San Lorenzo in Xunantunich area, Macanche, Quexil, Murrala de Leon, Cerro Ortiz, Tayasal/Paxcaman and Nakum in Belize Valley/Peten Lakes all show a decline during the Early Classic period. In the northern lowlands, Komchen is abandoned, Dizibilchaltun, Popola and Ek Balam show a decrease in occupation, and the two inland regions, Cochuah and the Ek Balam-periphery, also show a decrease of occupation during the Early Classic, corresponding in general with southern lowland occupation dynamics. However, there are other sites, such as Baking Pot, Yaxha, Cante Island, Sacnab, Salpeten, Zacpeten Peninsula, Petenxil and Quexil Island, which show growth during this period. In the northern lowlands, San Gervasio located on Cozumel Island shows the beginning of occupation during the Early Classic period. Interestingly, sites showing an increase in occupation during the Early Classic are mostly located on islands and peninsulas, showing the pattern which, as discussed above, appears again even more prominently during the Terminal Classic and especially the Postclassic period. Furthermore, a decrease in occupation occurs again after many sites and regions experienced a demographic peak and socio-cultural and economic flourishment during the Late Preclassic period (400 BC–AD 100).

Recent research pushes the development of many aspects of Maya culture, originally assumed to originate in the Classic period, back to the Preclassic. Not only the colossal and elaborate monumental public architecture with large stucco mask facades and early stelae and altars, but also the institution of divine kingship (Fields and Budet 2005; Kováč et al. 2016), the hieroglyphic writing system (Saturno, Taube and Stuart 2005; Saturno, Stuart, and Beltrán 2006; Kettunen and Helmke 2014), and the development/use of intensive agriculture (Beach et al. 2002; Murtha 2002; Wyatt 2005, 2008), all seem to have emerged during the Preclassic period (mostly the Late Preclassic). The Preclassic inscriptions are rare and often difficult to decipher and do not provide much information about political organisation and relationships between individual polities (in comparison to the Late Classic texts), therefore socio-cultural changes during the Preclassic period are much more difficult to assess. However, the iconography and writing on the San Bartolo murals (circa AD 150) and inscriptions and iconography found on objects found in the ritual cache in Uaxactun (circa 10 BC) indicate that the institution of kingship was developed by the end of the Late Preclassic (Saturno, Taube and Stuart 2005: 41–48; Kováč et al. 2016).

Somewhat counterintuitively then, the end of the Late Preclassic also brings a cessation of monumental construction of striking proportions, or the end of the 'Age of Monumentality' as the Late Preclassic period has been dubbed by Richard Hansen (2001: 59). With the colossal dimensions of the Late Preclassic structures, such as La Danta pyramid of El Mirador, rising to 70 m of height (Hansen 1998: 77) and most likely the largest structure ever built in the Maya world (Guenter 2014: 33); the 32 m tall El Tiburon complex with double triadic group, only recently discovered at Uaxactun (Kováč et al. 2015); and structure N10–43 from Lamanai, 33 m tall (Pendergast 1981: 41), this description of the Late Preclassic period is more than fitting. In many cases, structures built during the Preclassic Period remain the largest and often most elaborate (for example, featuring huge mask façades) buildings for the rest of the site's history, including the Late Classic period (for example, Lamanai structure N10–43, Pendergast 1981: 41). Another significant change occurring at the end of the Preclassic period, both in the southern and northern lowlands, is diversification and intensification of agricultural strategies and the development of more active water management. While the majority of the Middle Preclassic communities most likely relied on non-intensive slash-and-burn agriculture (but see Wyatt 2009: 7), by the end of the Late Preclassic period, there is substantial evidence of intensive agricultural techniques, such as terracing and wetland agriculture (see Killion et al. 1989; Pyburn 1998; Dunning 1996; Dunning et al. 2002, Chase et al. 2011, Luzzadder-Beach et al. 2012; Beach and Luzzadder-Beach 2013).

9.3.1. Terminal Preclassic/Early Classic versus Terminal Classic/Postclassic

Looking more closely at these two periods, there are several general patterns that can be recognised in these transitional periods in both case study regions.

(a) A period of growth is followed by demographic decline at the majority of sites, and in both case study regions, those few sites experiencing an increase in population during these periods are located mainly on islands, peninsulas and in coastal areas.

(b) There is a change/decrease in monumental construction during both the Terminal Preclassic, and the Terminal Classic period.

(c) There are changes in subsistence strategies during the Late Preclassic (intensification of agricultural strategies) and between Terminal Classic and Postclassic periods (possible eventual return to slash-and-burn agriculture).

(d) Both the Terminal Preclassic and the Terminal Classic period experience socio-political changes – development of divine kingship and possible growth of dynasties during the Terminal Preclassic period and likely rejection of the divine-kingship concept and political disintegration during the Terminal Classic.

Were the changes in these two periods caused by the same processes or different ones? Can the explanation of changes in one period help us to understand the changes and their causes in the other period?

Terminal Preclassic and Terminal Classic, also known as periods of the Preclassic Abandonment and the Classic Maya Collapse, are some of the most debated periods in Maya archaeology, and connections between them have been made before (mostly in terms of both of them being linked to droughts; for example, Gill 2000; Dunning et al. 2014; Guenter 2014: 348; Akers et al. 2016). Although this study does not focus on an explanation of processes behind the Maya collapses but on the more general human-environment relationship, when attempting to explain some of the patterns and processes discussed in previous chapters and above, some overlap with the topic is inevitable. In following part, I will, therefore, briefly discuss some hypotheses and factors proposed as causes of (especially) the Classic Maya collapse, however, I will keep the main focus of the discussion to the results and observations made in the previous chapters of this study.

9.3.2. Maya collapse(s)

Starting with the decrease in occupation rates: explanations vary, covering socio-political, economic and environmental factors. These include explanations based on population dynamics, resource productivity (for example, Malthusian equilibrium and ceiling; Malthus 1798), socio-political dynamics (for example, socio-political instability, political fragmentation; Tainter 1988; Wood 1998; Demarest 2004b; Turchin 2005) and environmental factors (for example, environmental degradation, climate change, environmental disasters; Gill 2000; Guenter 2014).

The decrease in occupation after the Late Preclassic period comes after a period of significant growth in population (although in a large majority of cases, levels of population appear to have been still far below those for the Late Classic period). Diversification and intensification of agricultural strategies during this period has been, therefore, used to support the hypothesis that the landscapes were reaching the carrying capacity and were overpopulated. As discussed in Chapter 7, however, intensive agricultural and water management techniques appear, in most cases, before the population maximums. Instead, the discussed evidence indicates that although population pressure may have been one of the stimuli behind the adoption of these techniques, land degradation as a consequence of the slash-and-burn agriculture (possibly also deforestation due to huge construction projects), perhaps further exacerbated by the drying trend at the end of the Late Preclassic period, is a more likely factor. Such a hypothesis is supported by ethnographic evidence. As discussed in Chapter 4, changes in subsistence patterns and agricultural strategies were listed as some of the coping strategies used in the face of environmental stress. In the case of demographic decline during the Terminal Classic period, population pressure is a more likely factor. Further intensification of agricultural strategies and centralisation of agriculture and water management in many areas during the Late Classic indicate an increased demand for food and water.

One of the counter arguments used when discussing population decline (especially during the Terminal Classic period), is that the data obtained from settlement surveys, and to some extent from archaeological excavations, are exaggerated, underestimating numbers of 'hidden mounds' and perishable structures. This is definitely a fair point that needs to be taken into account, although it remains one that is difficult to deal with given preservation issues. As discussed in Chapter 3, however, in many cases, perishable structures would have been constructed on platforms and 'hidden mounds' (structures without platforms) can sometimes, depending on surface conditions, be detected by artefact scatters[24]. Furthermore, even if people were living in perishable structures, they still need to farm. Palaeoenvironmental data, however, often confirm no evidence of agricultural activity (Guenter 2014: 326). Calakmul, one of the superpowers of the Maya world during the Late Classic period was, to judge from both archaeological and epigraphic evidence, abandoned by the beginning of the 10th century AD (Braswell et al. 2004; Martin and Grube 2000). This is supported by palaeoenvironmental research conducted in the Mirador Basin, which, according to Wahl and colleagues, indicates the decline of agricultural activity at the beginning of the 9th century and none after the mid-9th century, as no maize pollen was found in the sediment core thereafter (Wahl et al. 2007; Guenter 2014: 326).

Other hypotheses are more focused on socio-political factors, such as internal or external warfare, intra-elite competition, ideological changes and political disintegration, with consequent abandonment of large cities, moving back to hinterlands, or migration. On discussing the relationship between population decline and socio-political instability, Peter Turchin says:

> Instability can also affect the productive capacity of the society. First, the state offers protection. In a stateless society people can live only in natural strongholds, or places that can be made defensible. Examples include hillfort chiefdoms in preconquest Peru (Earle 1997), and the movement of settlements to hilltops in Italy after the collapse of the Roman Empire (Wickham 1981). Fearful of attack, peasants can cultivate only a small proportion of productive area that is near fortified settlements … Second, states often invest in increasing the agricultural productivity by constructing irrigation canals, roads, and flood control structures. A protracted period of civil war results in a deterioration and outright destruction of this productivity-enhancing infrastructure (Turchin 2005: 1–2).

[24] I have detected many such scatters during my survey at Baking Pot, although admittedly the situation there is made much easier because most of the area was turned into pastures and fields.

In Maya studies, the idea that warfare was a main factor in the Maya collapse(s) has long been one of the most popular hypotheses. After the breakthrough in the decipherment of Maya writing in the 1980s, the idea of a peaceful Maya civilisation had to be abandoned (Schele and Freidel 1990). Warfare proved to be one of the most common themes in Maya inscriptions, especially in those dating to the Classic period. However, as discussed in Chapter 8, while we see various changes appearing in the epigraphic record at the end of the Late Classic and the beginning of the Terminal Classic period, the number of warfare related inscriptions, rather than increasing, as we would expect to be the case if warfare was a causal factor in the Classic Maya Collapse, shows a decrease. In fact, war inscriptions completely disappear during the Terminal Classic period (Grube 2013, Guenter 2014: 317). This is not to say that warfare did not exist during this period (as known from archaeological evidence), however it does not seem to play as important a role in Maya narratives as it did during the Late Classic. After AD 800, warfare gave way to descriptions of joint rituals performed by former adversaries, references to period endings, and increased ritual activity (Grube 1994; Martin and Grube 2008; Helmke et al. 2010, including the rain-calling rituals discussed in Chapter 8). It has been suggested that the collapse, in fact, started much earlier than in the 9th century (see Demarest 2004a, Stuart 1993). The increased references to warfare during the Late Classic period are perceived by some researchers as indicators of social problems and tension within Classic Maya society. Demarest (2004a: 257) proposes that such tensions were: 'exacerbated in the seventh and eighth centuries by increasing inter-elite status rivalry, the growing proportion of elites in the population, and the consequent increase in inter-elite competition for limited positions of royal power and for status-reinforcing exotic goods. This cycle of contradictory demands on the system increased inter-center warfare, rapidly devolving into more widespread conflict as the basic infrastructure of the region was disrupted.'

Especially in the Pasión region, increased evidence of warfare has been closely linked to its presumably early collapse in the late 8th and early 9th centuries (Demarest 2004a: 253; O'Mansky and Dunning 2004). This would be decidedly earlier than the decline of the other centres in the southern Maya lowlands (but see Guenter 2014: 167–206). Furthermore, palaeoenvironmental studies do not indicate problems with deforestation or soil erosion, the timing of the Pasión region decline did not fit with rainfall change, and neither were there signs of malnutrition or disease (Dunning, Beach and Rue 1997; Wright 2006). Instead, there is evidence of fortifications and occupation at defensible positions (see Demarest et al. 1997). In the Petexbatun region, there is an occupation shift 'to fortified defensible locations such as hilltop fortresses and the artificial island of Punta de Chimino' (Demarest et al. 1997: 220). Punta de Chimino is a small island on Lake Petexbatun, which, like Zacpeten in the Peten Lakes region, was originally a peninsula that was later transformed into an island (Rice et al. 1998: 225). During the Terminal Classic period, it was fortified and it was the only site in the Petexbatun region still occupied during the ninth century (Demarest et al. 1997).

A similar situation is apparent in the Peten Lakes region as discussed in Chapter 6, where Zacpeten Peninsula and Quexil Islands experience an increase in occupation during the Terminal Classic period. Furthermore, Muralla de Leon, which is located on an elevated plateau at the northeast end of Lake Macanche and encompassed by water from three sides, is surrounded by a dry-stone wall which, as it was suggested, might have functioned as fortification (Rice and Rice 1981). The wall was first constructed during the Late Preclassic period, but given the size of the settlement inside the wall, it might have served to protect limited number of people, possibly the elite, or only functioned as a temporary refuge (Rice and Rice 1981: 283). The small settlement was abandoned during the Early Classic period, briefly reoccupied during the Late Classic, abandoned again during the Terminal Classic but reoccupied again, and the wall was most likely reused during the Postclassic period (Rice and Rice 1981). More evidence of possible fortifications, although some of them might have served simply as boundaries, are recorded both from the Late Preclassic and Terminal Classic periods (for example, the El Mirador wall and ditch, dating to the Late Preclassic: Morales-Aguilar 2010: 76; Becán fortification ditch constructed between AD 100–250: Webster 1977: 360; Edzna fortress and a moat built between 250 BC–AD 100: Matheny 1976: 640–64; fortifications dating to the Late Classic/Terminal Classic transition were found at Seibal: Tourtellot and González 2004: 76, Aguateca and Dos Pilas: Demarest at al. 1997).

These fortifications are usually seen as a consequence of warfare. There are a couple of other hypotheses to be considered as well, however. Some of these walls could be linked to growing trade and commerce (Elizabeth Graham pers. comm. 2017), as many walls were built in order to control the movement of people and goods and to collect tolls (for example, walls of medieval towns or Roman cities; Brady 2003; Pinder 2011). Alternatively, given the size of many of these fortified settlements, it is also possible that people moved to these highly defensible positions close to water after the populations were already significantly reduced, perhaps as a result of something else, drought being one of the factors suggested (see Gill 2000; Guenter 2014). The amount of land available for agriculture in these locations would have been very limited, which may have led to conflict and, therefore, the need for fortification of even fields and water sources, as is the case in the Petexbatun region (Demarest et al. 1997; Guenter 2014: 177). In fact, Guenter suggests that the sudden appearance of Tikal's emblem glyph at small sites such as Zacpeten and Ixlu, while Tikal shows hiatus in erecting monuments, might indicate that the capital of Tikal kingdom moved to these smaller defensible locations. He proposes the same scenario occurring with surviving people from Aguateca moving to Punta de Chimino and people from the Motul de San José moving to the island of Flores (Guenter 2014: 331).

The fact that this pattern of increase of occupation on islands and peninsulas accompanies both the Terminal Preclassic/ Early Classic and the Terminal Classic occupation decline, while at the same time in both cases corresponding with periods of diminished precipitation, lends further support to drought being one of the factors involved. As discussed in Chapters 5 and 6, there is abundant evidence of periods of reduced rainfall or even severe droughts both during the Late Preclassic and Terminal Classic periods, as indicated by various palaeoclimatic proxies from different regions. With the increasing number of palaeoclimatic records and growing focus on climate change issues in archaeological studies, drought became one of the most popular models explaining the Classic Maya collapse and, more recently, the Preclassic abandonment (for example, see Gill 1994, 2000; Hodell et al. 1995, 2001, 2007; Gunn et al. 1995; Curtis et al 1996, 1998; Lucero 2002; Haug et al. 2003; Shaw 2003; Webster et al. 2007; Kennett et al. 2012; Guenter 2014; Kennett and Beach 2014; Douglas et al. 2015b, 2016; Akers et al. 2016). The drought hypothesis has also been criticised by many (for example, Demarest 2004b; Demarest et al. 2004; P. Rice et al. 2004; Yaeger and Hodell 2008). One of the main criticisms of the drought model is its monocausality and attempts to explain what many people see as a long-term process (or in some cases, transformation rather than collapse), with different regions having different chronologies and possibly being affected by different factors and processes. Critics of the drought model often argue that the first regions to decline were those in the southern lowlands located on large rivers, while northern lowland sites, which have fewer surface water sources and receive less rainfall, survived much longer. However, Guenter, who explored Classic Maya collapse chronology through dates in Maya hieroglyphic inscriptions, argues not only that the collapse process in Petexbatun region started approximately at the same time as everywhere else in the southern lowlands, but also that the chronology of decline of northern lowlands sites matches that of the southern lowlands. He argues that the northwestern Yucatan sites show a hiatus in the commissioning of monuments between 815 and 849, with no inscriptions appearing after 910, thus paralleling the situation in the southern lowlands (2014: 266). Douglas and colleagues, based on the palaeoclimatic data synthesis, also argue that the timing of the onset of the dry intervals vary between the southern and northern lowlands, but between individual regions as well (2016: 622–623). Recent hydrogen isotope ratios of plant-wax lipids (∂D_{wax}), derived from the lake sediments of Lake Chichancanab in the northern lowlands and Lake Salpeten in the central lowlands, indicate that the dry conditions recorded between AD 730 and 1100 in the central lowlands did not really start on the northern Yucatan peninsula until the end of the eight century and the records also suggest that this dry period was considerably more intense in the central Peten than in the northern part of Yucatan Peninsula (Douglas et al. 2015b, 2016: 628).

Instead of focusing on chronological differences or on how much of a role drought played in the collapse(s), I would like to discuss an issue that I think is underemphasised in the debates about the drought model in particular, within the discussion of the Maya relationship with their environment in general, and which I consider one of the contributions of this study.

9.4. Environmental conditions and Maya resilience

The environmental differences between the southern and northern lowlands and between the individual regions in both areas have been widely discussed in many studies and above in Chapters 2, 4 and 7. Curiously, the impact that these differences would have on subsistence strategies, water management, socio-political and economic complexity, and how it would affect Maya ability in these different regions to deal with environmental stress, have rarely been considered. Studies criticising the drought model often emphasise the lower (in comparison to the southern lowlands) amount of rainfall and limited agricultural potential of the northern lowlands in general, although as presented by Dunning and colleagues (1998), the area can be divided to different regions (27 in their division) with distinctive environmental conditions including soils, water access, rainfall patterns and consequently subsistence strategies. Studies arguing for drought as a major, or the only, factor rarely stress these differences either, as it is difficult to reconcile the monocausality of the drought model with the regional differences, without further discussion on how they affect other aspects of Maya-environment relationship.

One of the main goals of this study was to look at regions with different environmental conditions to assess the impact these differences have on settlement patterns, subsistence and water management strategies and coping strategies in the face of environmental stress.

One of the main differences between the southern and northern lowlands is access to water. As discussed in Chapter 7, despite the northern lowlands' lack of surface water sources such as rivers, streams or lakes, the ground water is very close to the surface and easily accessible by means of *cenote*s or wells. On the other hand, in the southern lowlands, the water table is too deep or too unpredictable in many areas to dig wells (Folan et al. 1983a; Siemens 1978; Harrison 1993: 78) and, especially in the areas without surface water sources, this would be a major disadvantage during the periods of reduced rainfall. This difference in access to water is reflected in different water management strategies, with many areas in the southern lowlands developing sophisticated water management systems and urban water reservoirs, in some cases very likely controlled by the elites (for example, Tikal, Nakum, Baking Pot). The elite water control and its role in the Maya collapse might be over-emphasised in some studies, especially if presented as a blanket explanation for abandonment of many of the Maya centres during the Terminal Classic period. In the majority of cases, large urban reservoirs would not have been the only source of water available.

On the other hand, the reliance of densely populated urban centres without natural water sources on water reservoirs, such as Tikal or El Mirador, might have made them more vulnerable to prolonged droughts. While the water security initially increased with the construction of the reservoirs and may have even served as a settlement attractor, it also generated 'high social and political dependencies and economic vulnerability' (Isendahl et al. 2016). Such systems would have required the availability of labour and investment and once depopulation began, they may have deteriorated (Dunning et al. 2012). Such a situation would have rarely occurred in the northern lowlands, mainly because there is not much evidence of large reservoirs at the northern lowland sites (except in the Puuc region, see Isendahl 2001).

It is also often argued that better access to water does not help in the case of rain-fed agriculture that Maya civilisation mostly relied on. The northern lowlands, with low rainfall and thin soils, are presented as areas with low agricultural potential and are, therefore, perceived as more vulnerable to droughts than the southern lowlands. Besides this assumption already being problematic due to the highly variable rainfall patterns in the different regions of the northern lowlands, the amount of rainfall is not the only variable that affects agriculture. In comparison to the southern lowlands, their northern neighbours have relatively regular, less seasonally variable rainfall. As discussed in Chapter 4, one of the most frequent complaints of the contemporary Maya farmers, when they were talking about perceived climate change (change in weather patterns during their lifetime), was that the rainfall became unpredictable. The onset of the rainy season became too irregular to predict, which led to a change in the planting pattern. Instead of planting two weeks before the anticipated onset of the rainy season, people waited to plant until after rains began. This not only shortens the growing season, sometimes considerably, but it also leads to a high risk that plants will be too small and vulnerable to withstand the heavy rains, which come in July. Exploration of the modern rainfall data (1935–2005) confirmed the increase and shift of intra-annual variability after the late 1960s from April to May (especially in the Toledo district), indicating that the onset of the rainy season has been unpredictable, sometimes starting earlier and sometimes later. Furthermore, the analysis showed increased variability in precipitation in February from 1993 onwards. The February–March period corresponds with the time of burning, which also requires careful timing: before the onset of the rainy season so the vegetation on fields burns properly (producing the fertilising ash), but not too early so the weeds do not have time to establish before planting. In this respect, the northern lowland's lower variability in rainfall might have been beneficial for agriculture. Relatively regular rains would have made the process of cutting and burning the vegetation and planting of the crops easier and less dependent on the right timing, and less heavy rain would not leach out nutrients out of the soils as quickly as in area with higher rainfall (Ringle 1985: 179).

The argument that wetter areas (ones that receive more amount of rainfall than necessary for maize agriculture) would not be affected by the drop in the rainfall indicated by palaeoclimatic proxies (see Yaeger and Hodell 2008) might be equally simplistic. The Toledo district is one of the wettest regions in the whole Maya area, but modern farmers have been complaining about the increasingly dry conditions and unpredictable rainfall. Moreover, it is not only reduced rainfall that can be problematic. Excess of rainfall, especially in these rain-rich regions, may damage the crops as well (for example, if it comes too late and the stalks are too small to withstand the heavy rains or the rains can make the crops ripen too quickly so they rot). Interestingly, the study looking at the possible agricultural/rainmaking rituals expressed in Classic Maya texts (Chapter 8) offers further support to the hypothesis that variability in rainfall is an important factor. The results of the analyses discussed in detail in that chapter indicate that the 'bathing' rituals (and also the *chok* rituals during the Terminal Classic period), as petitions for rain, might indeed have played a more important role in the region with potentially shifting precipitation regimes, where variation between high and low annual rainfall is likely to have a considerable effect. I think that the potential vulnerability of the maize agricultural cycle and the importance of right amount of rainfall at the right time has been so far vastly underestimated, even in studies discussing climate change/drought as a major factor in the Maya collapse (Guenter 2014 and Akers et al. 2016 are rare exceptions).

At the same time, it is undeniable that some parts of the northern lowlands (for example, the northwest corner of Yucatan) do have comparatively low agricultural potential because of shallow soils and low rainfall; such conditions would however, promote development and the use of highly diverse intensive agricultural strategies. Stoner (2017:93), based on a study of agricultural intensification and collapse across the Gulf lowlands argues that: 'There is a negative correlation between the intensified field area and annual precipitation and number of months of soil moisture suggests that agricultural intensification was linked to reducing risk associated with exclusive use of rainfed (non-irrigation) agriculture'. Diverse, intensive agricultural strategies did not only exist in the dry northwest corner of Yucatan Peninsula. Various forms of intensive cultivation appear in different regions of the northern lowlands, likely driven by the highly variable environmental conditions. As discussed in Chapter 7, the appearance of wetland features in the Yalahau region most likely dates to the Preclassic period, paralleling intensification of agriculture in the southern lowlands. On the other hand, use of depressions with deeper fertile soils *(dzadzes, rejolladas)* for sowing various plants, including valuable crops such as cacao, might have always been part of the subsistence strategies in the northern lowlands. Moreover, agriculture oriented subsistence strategies in the northern lowlands, at the very least in some areas, seem to be heavily complemented by other types of economies, such as fishing, salt production and trade. Chunchucmil, for example, offers evidence of many different intensive cultivation strategies, such as

orchards, raised beds with imported organic soils and pot irrigation. These techniques, however, were argued to be not enough to feed the dense population (Beach 1998b) and, therefore, they were supplemented by various other strategies including food import and trade (Beach 1998b; Luzzadder-Beach 2000; Dahlin et al. 2005, 2007).

Both highly intensive agriculture and variable economical and subsistence strategies are likely reflected in the settlement patterns of northern lowland sites such as Chunchucmil or Mayapan. Their unusually high population densities (Mayapan: 17 000/9–10km^2; Chunchucmil: 35–43,000/20–25km^2; Russel 2008: iii; Magnoni: 2008; Magnoni et al. 2012: 315) reach values closer to those of central Mexican sites (also known for intensive agricultural strategies and trade) than sites in the southern lowlands (Hanson 2008). In contrast, with more rainfall and better soils, there would be less pressure on intensification and diversification of agricultural strategies in the southern lowlands and, as mentioned above, their appearance during the Late Preclassic period seems to be driven more by soil erosion, possibly coupled by diminished precipitation during this period, than by population pressure (at least at that period of time, as population pressure seems to have played larger role in further intensification of agriculture during the Late Classic). Even after intensive agriculture was adopted in the southern lowlands, it has been argued to be relatively rare apart from the Belize Valley, Vaca Plateau and Northern Belize regions (Dunning and Beach 1994: 52, although this view has been changing as more intensive-agricultural features are being identified and studied with growing use of LiDAR survey, for example, features identified in Caracol, Uaxactun and other sites in Northern Guatemala (Hightower et al. 2014, Chase and Weishampel 2016, Canuto et al. 2018, Kováč 2019). The less dense and nucleated settlement pattern of the southern lowland sites would then reflect the different, often less intensive agricultural strategies (see Graham 1996; Dahlin et al. 2007).

Differential adaptation to environmental conditions, in terms of subsistence strategies, water management and settlement patterns and, consequently, different responses to environmental stress between the southern and northern lowlands, are also supported by the comparison between palaeoclimatic records and settlement occupation rates (Chapter 6). Although the analysis was only of exploratory value due to the low chronological resolution of the occupation data, the subsequent chapters, in fact, confirmed some of the observations made from these comparisons. The analysis indicated a stronger relationship between changes in rainfall and changes in settlement levels in the southern lowland study regions, with the important observation that the occupation changes usually occur after relatively abrupt, rather than gradual, changes in rainfall, when there was little possibility of gradual adaptation. On the other hand, the relationship between changes in precipitation and changes in occupation appears to be weaker in the northern lowlands, with the exception of the Yalahau region (whose position as an exception is understandable given its wetland nature). The relative lack of the relationship between these variables in the northern lowlands further supports the hypothesis discussed above, that this region might have been better able to deal with dry conditions because of a long-term adaptation process involving several different factors, such as less reliance on maize agriculture (see Mansell et al. 2006), adoption of diverse, less rain-dependant economies (trade, salt processing, fishing), a different water management system (that is, use of wells and *cenotes* to access the close-to-surface groundwater) and, possibly, a different, less hierarchical, political organisation.

The traditional perception of the Maya area as a homogenous entity has been changing gradually, especially with the increased regional focus of research, and political, linguistic and cultural differences have been identified and acknowledged in many recent studies. I focused mostly on the impact of environmental conditions in different regions on many aspects of peoples' lives, including settlement patterns, economic and subsistence strategies, water management and the ability of people to deal with environmental stress.

9.5. Precipitating change: Lessons for the future

This work has brought together a range of evidence from ethnography, archaeology, paleoclimatology and epigraphy to explore the relationship between Maya society and the local environment over the long-term and across different regions. By combining different approaches and range of evidence in a novel way, I attempted to move debate about human responses to environmental stress, drought in particular, beyond the correlation implies causation fallacy and thus to contribute to a better understanding of human-environmental relationships in general. Furthermore I aimed to show that by using a holistic approach, combining archaeological, historical, ethnographic and environmental data we can build a bridge between short-term weather effects and people's responses to them during the present, and the long-term climate change, its effects and human adaptation strategies in the past. In that way, specific experiences from recent past or present add a rich nuanced details and help us better understand the patterns in the past data. In turn, better understanding of past experiences and long term adaptation strategies developed, shared and adopted by communities over time, provide useful lessons for the future and can play important role in current climate change debates.

Lessons from past climate change resilience

Some of the observations from this work are not only relevant to Maya studies and the past, but have local, global and modern implications.

For example, people's perceptions of drought and how they feel its impact is different from scientifically defined drought, based on average amount of rainfall, and this is still underemphasised in studies dealing with droughts in

particular and has wider implications for other climatic events in general. The impact and, consequently, the perception of environmental events and climate risk varies in different areas and in different conditions, and so too do mitigation and adaptation strategies. Differences in responses to environmental stress are a function of complex set of environmental, cultural, social and economic factors (for example, types of soils, water access, amount and variability of rainfall, ethnic backgrounds, beliefs, economic resources, opportunities for work).

Closely related is another finding that abrupt changes in rainfall, and thus short-term perception of change and risk, are more strongly correlated with settlement changes than are gradual changes (i.e., when there is more time to adapt to these changes). This observation has an important implication for population mobility and environmental/ climate refugees and, in a wider context, for the issue of social vulnerability and mitigation strategies. Although climate change as the sole factor in migration is rare, it is widely recognised as a contributing and exacerbating element in migration and in conflict (Podesta 2019). Migration as an adaptive response to climate stress is already evident in many areas today, and the estimates of future climate migrants, affected by changes in monsoons and other rainfall regimes, severe droughts and by sea-level rise and coastal flooding, are worrying. They range between 25 million and 1 billion people by 2050 (IOM 2008). The ability to migrate is, however, closely correlated with mobility and resources (both economic and social). Very often, the people most vulnerable to climate change are the ones who are least likely or able to migrate. As observed in Chapter 4, environmentally stressful events create moments of vulnerability that are easily exploited, can exacerbate economic and political inequality, and can have long-term repercussions. Nazrul Islam and Winkel (2017) state that the relationship between climate change and social inequality is 'characterized by a vicious cycle, whereby initial inequality causes the disadvantaged groups to suffer disproportionately from the adverse effects of climate change, resulting in greater subsequent inequality.' Evidence from a number of studies shows that recovery from adverse climatic events by disadvantaged groups is indeed slower than by groups with better resources (see Kraay and McKenzie 2014, Carter et al. 2007). Furthermore, the way that the disadvantaged groups cope with climate hazards is due to lack of resources often detrimental to their future adaptive capacity and growth (Nazrul Islam and Winkel 2017, Barbier 2010, Barret et al. 2011).

Finishing on a more positive note, findings from our ethnographic fieldwork show a wide variety of short-term strategies to cope with the extreme weather events (for example relying on traditional ecological knowledge or seeking wage labour), as well as ways to adjust to changes, that in the long run may prove to be adaptive (for example adjusting planting schedule, new crops, mechanisation of agriculture). It is also clear that extreme weather events can be remembered for a long time, which helps with accumulation of traditional knowledge and development of long-term adaptation strategies.

There is a growing body of literature where local indigenous knowledge and climatic science have been integrated to explore perceptions, vulnerabilities and adaptation strategies among present day communities (often farmers or pastoralists) (Ogallah et al., 2017; Dakurah, 2020; Metcalfe *et al.*, 2020). Many of these studies are criticized and among the issues discussed is a lack of engagement with these communities and only surface deep descriptive studies revolving around 'vulnerability, verifiability, and viable adaptation, rather than beginning from an understanding that farmers are capable experts' (Soubry et al., 2020: 218). Comparisons of peoples' perceptions with climatic data (e.g., temperature, rainfall, onset and finish of the rainfall) to assess match or mismatch between the two in these studies, show that farmers are, in the large majority of cases accurate in their observations. 'Where farmers were evaluated against historical data, 87% of papers found them to be correct' supporting the call for them to be considered as experts (Soubury at al. 2020: 217). These results only reinforce the fact that people who use and depend on a land for their livelihood are intensely aware of the factors such as weather that can impact it; they make continuous and detailed observations and can perceive the long-term changes in weather conditions. Furthermore, many local environmental issues have a knock on global effect and the indigenous solutions to local problems can provide transferable lessons to solving global issues as well.

Therefore, all these observations, both from the past and from the present, offer practice-based evidence that can have wide implications for policy making in regards of climate risk assessment and for planning of climate actions and mitigation and adaptation strategies.

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Both the perceived successes and failures of the Maya are often linked to their relationship with the local environment and their response to episodes of climate change over a period of nearly 2000 years. However, our understanding of human responses to environmental stress has mostly been shaped by a narrow focus on drought as a cause for societal collapse, even in relatively well-watered tropical regions. We still know little about the choices humans make in response to extreme variability in rainfall in different environmental conditions and on multiple timescales. This work responds to recent debates and new analytical opportunities in Maya studies, provided by developments such as an increased volume of paleoclimatic data, the growing field of settlement archaeology and advances in Maya epigraphy. By combining a range of evidence, the book explores the relationship between Maya society and the local environment on multiple spatial and temporal scales, while also considering socio-cultural agencies. In addition, results from ethnographic fieldwork among contemporary Maya communities provide insights into the impact of stress-inducing climatic events on people's lives and their coping strategies. These serve as a guide when looking for similar patterns in archaeological and textual evidence.

Eva Jobbová is a Maya archaeologist interested in a broad range of topics including the development of Neotropical urbanism, the growth of social complexity and societal collapse, and the choices humans make in response to spatial and temporal variation in climate and environmental stress. Currently a Postdoctoral Research Fellow at University College Dublin, she is involved in a project focusing on Irish droughts.

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